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THE

PREVENTION

OF

LOSS BY FIRE.

BY

EDWARD ATKINSON, LL.D., Ph.D.

(President Boston Manufacturers Mutual Fire Insurance Co.)



BOSTON :

DAMRELL & UPHAM,

THE OLD CORNER BOOK STORE,

283 Washington Street.

1900.



The Prevention of Loss by Fire

FIFTY YEARS' RECORD

OF

FACTORY MUTUAL INSURANCE

BASED ON

THIRTY-FIVE YEARS' PERSONAL EXPERIENCE

WITH SUGGESTIONS FOR THE

Protection of Cities from Conflagrations

BY

EDWARD ATKINSON, LL.D., PH. D.

(PRESIDENT BOSTON MANUFACTURERS MUTUAL FIRE INSURANCE Co.)

BOSTON
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The Old Corner Book Store
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Life of

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BY EDWARD ATKINSON.

INTRODUCTION.

The system of Factory Mutual Fire Insurance, founded by the late Zachariah Allen, of Providence, R. I., is unique. It is the only instance known to the undersigned of an undertaking to couple the prevention of loss by fire as the prime motive of the organization, with the payment of indemnity in money for such losses as cannot be avoided as an incident.

About one thousand million dollars (\$1,000,000,000) of risks are now outstanding in all the Factory Mutual Companies of this kind.

I began this treatise with the intention of only stating a few dry facts and figures, which will be found in the first few pages, regarding the early history of the system and my own connection with it, upon record with the semi-centennial report of the Company of which I am President.

As the dictation progressed the details of our work in the investigation of the trivial causes of our heaviest losses were brought into view. It then became plain that when the remedy for the excessive fire loss of the country is sought, the same method of first seeking the trivial causes must be followed, and some way must be found for providing against them. It will be observed that the greater part of the fire tax is in the destruction of a relatively small number of large establishments, and not in the aggregate of a great number of small losses. When these large losses are investigated, especially in city warehouses and great shops, it appears that even when the buildings are of incombustible material, no right attention

has been given to separating one floor from another. It often seems as if the plans had been made so as to assure the complete destruction of the contents. Little or no attention is given by the occupants to the trivial causes from which great fires originate. Whenever we have been called upon to inspect large establishments outside our own risks, before the present methods of inspection by the Boston Fire Underwriters' Union were adopted, we were sure to find basements or dark cellars, encumbered with dangerous rubbish, attics and roofs of bad construction filled with combustible material, bad lanterns, swinging gas jets, worthless hose hung up to satisfy the "insurance man," etc., or, in fact, all the minor faults which it has taken so many years to remedy in the Mutual System. Such evils can only be remedied by owners and occupants.

I therefore feel justified in printing this somewhat personal narrative of our dealings with apparently very trivial matters, hoping that the facts stated may attract some attention.

I think this record may have an interest to the underwriters, who are now striving to elevate the profession from a system of betting that bad risks will not burn, to one that will give it a rank among the most useful occupations.

If it shall lead to any thoroughly organized method of preventing great conflagrations in cities, a matter which is to the Mutual underwriters so plain and simple that it seems passing strange that no more has been accomplished, I shall feel justified in its publication.

EDWARD ATKINSON.

BOSTON, MASS., U. S. A., March, 1900.

THE PREVENTION OF LOSS BY FIRE.

BY EDWARD ATKINSON.

(President Boston Manufacturers Mutual Fire Insurance Company).

THE undersigned, having been connected with the system of Factory Mutual Insurance more actively and for a longer period than any other living person, now presents a statement of facts and conclusions developed by thirty-five years' service in the Company of which he has been President for twenty-two years, hoping that it may be of use in putting a stop to the excessive fire tax of this country.

The system was established by the late Zachariah Allen, of Providence, Rhode Island, in the year 1835, when he and his associates organized the Providence Manufacturers Mutual Fire Insurance Company. In 1848 the Rhode Island Mutual Fire Insurance Company was established.

The Boston Manufacturers Mutual Fire Insurance Company was established in 1850, as the writer believes, at the instance of Mr. James Read; the first Secretary, Mr. John L. Hughes, being brought over from Providence to aid in the work. He was shortly after obliged to resign on account of ill health, Mr. Edward E. Manton, of the Rhode Island Mutual Company, becoming the executive officer of this Company, practically retaining the executive control of the Rhode Island Mutual and being the chief adviser of the Manufacturers Mutual, of Providence. Only one gentleman is living of those who founded

this Company, Mr. Charles S. Storrow, to whose credit this useful work may be attributed, together with many other services which he has rendered. The undersigned was elected a Director in 1865 and became President in 1878, making thirty-five years of more or less active service out of the fifty years which have nearly elapsed since the Company was organized.

On January 1, 1900, the Boston Manufacturers Mutual Fire Insurance Company entered upon the fiftieth year of its existence. The first policies issued were dated September 14, 1850. In that and in the ensuing year, 1851, one hundred and eighty (180) original policies were issued to one hundred and ten (110) members in the sum of \$3,320,560. The cash premium or deposit subject to losses and expenses amounted to \$33,320. The maximum hazard taken on a single risk was thirty thousand dollars (\$30,000). The rates varied from a minimum of forty (40) cents on some storehouses to one and one-half (1½) per cent. on certain mills. These rates had been established by the two older Providence Mutual Companies, the Manufacturers' Mutual and the Rhode Island Mutual. I am informed that the Mutual rates were made on the basis of the schedule of some of the older Stock Fire Insurance Companies, at three-quarters the charge made by the Stock Companies on the same property.

It is evident that the Members and Directors rested upon the power of assessment more than upon the cash payment in the early history of this and other Factory Mutual Companies, yet, since 1850, there has been no assessment required by this or any other of the Associated Factory Mutual Companies.

During the earlier period of their history the picker departments of cotton and woolen factories were not insured

by the Mutual Companies, nor can I find any evidence that they were separately insured. The risk was probably carried by the owners. It was deemed excessive. But immediate measures were taken for protecting pickers in much greater measure than for the protection of mills, and from computations which I have recently made of the proportions of loss in ratio to value of picker buildings and contents as compared to the main mills and contents, the loss relatively has been less than in the works proper; thus proving again the one rule developed in this work, a rule which must be fully comprehended outside the lines of the Factory Mutual Companies if the terrible losses by fire in the United States are to be reduced. The rule is as follows:—

After the Insurance Company has done its duty by careful selection of risks and thorough inspection, all that it can do is to pay indemnity for loss which, if large, is in nine cases out of ten due either to the lack of apparatus for preventing such loss, or to lack of care and order in the conduct of the work. The only persons who can prevent loss by fire are the owners or occupants of the insured premises. Upon them rests the responsibility for heavy loss when any occurs in nearly every fire.

It has always been the practice of the Mutual Companies and of late, with excellent results, the practice of the Stock Insurance Companies to instruct owners and occupants upon their duties to their own property and to keep them up to the mark by constant supervision and by refusing to grant contracts of indemnity to those who neglect their own duty.

The most difficult work of the President of a Mutual Fire Insurance Company is to do away with the antagonism of owners against the underwriters, and to secure that

co-operation in preventing loss by fire which ensues as soon as the identity of the interest of the owner and the underwriter is established.

In 1850, when the Boston Manufacturers Mutual Fire Insurance Company was organized, the Manufacturers Mutual Fire Insurance Company, of Providence, Rhode Island, had been in operation for fifteen years; the Rhode Island Mutual Fire Insurance Company for three years. Each of the above-named companies issued policies not exceeding fifteen thousand dollars (\$15,000) on a single risk. This Company began by issuing policies not exceeding thirty thousand dollars (\$30,000) on a single risk.

The Firemen's Mutual Fire Insurance Company was organized in 1854, the Worcester Manufacturers Mutual in 1855, the State Mutual, of Providence, in 1858, and the Arkwright, of Boston, in 1860. Several years elapsed before any other Mutual companies were organized.

The following companies, with those previously named, constitute the New England Factory Mutual Companies, which, with two in Philadelphia, have combined for the purpose of joint inspection, supply of plans and other work of like kind.

Blackstone Mutual Fire Ins. Co. . . .	Providence, R. I.	1868
Fall River Mfrs. Mutual Ins. Co. . . .	Fall River, Mass.	1870
Mechanics Mutual Fire Ins. Co. . . .	Providence, R. I.	1871
What Cheer Mutual Fire Ins. Co. . . .	Providence, R. I.	1873
Enterprise Mutual Fire Ins. Co. . . .	Providence, R. I.	1874
Merchants Mutual Fire Ins. Co. . . .	Providence, R. I.	1874
Hope Mutual Fire Ins. Co.	Providence, R. I.	1875
Cotton and Woolen Mfrs. Mutual Ins. Co.	Boston, Mass.	1875
American Mutual Fire Ins. Co.	Providence, R. I.	1877
Rubber Manufacturers Mutual Ins. Co.	Boston, Mass.	1886
Paper Mill Mutual Ins. Co.	Boston, Mass.	1887

The losses have never been so great in any one year as to subject either one of these companies to the necessity of making an assessment in addition to the sum deposited at the beginning of each term, during this period of fifty years. Had this property been of necessity insured in any other way than by the Factory Mutual Companies, there would have been two periods, one immediately after the Chicago fire and one immediately after the Boston fire, when a large part of the contracts of indemnity which had been paid for would have become worthless. That danger of great city conflagrations still exists.

The secret of this success is to be found in the fact that when men combine with each other for mutual insurance they very soon learn the one lesson, which I repeat:—

The only persons who can prevent loss by fire are the owners or occupants of the insured premises. Upon them rests the responsibility for heavy loss, if any occurs, in nearly every fire. All that the Insurance Company can do is to pay indemnity for loss, which, if large, in nine cases out of ten is due to the lack of apparatus for preventing loss or to lack of care and order in the conduct of the work.

At later dates eight other factory mutual companies have been organized in Massachusetts and Rhode Island, and are now associated with the ten Senior Companies for the joint inspection of risks, but as they came in after the greater part of all the older risks had been covered by the Senior Companies, they extended their service over such large concerns as could not be wholly covered by the Senior Companies and over other classes in a wider area, in which service they have rendered a proportionate benefit to their members: their earlier dividends exceeding those of the Senior Companies in their early history; their recent divi-

dends exceeding those of the Senior Companies down to and including 1879, when great changes were made in the general conduct of the system as will be hereafter stated.

The undersigned was elected a Director of this Company in the year 1865. He then had charge of placing the insurance of seven corporations of which he was either treasurer or assistant treasurer in charge of this branch of their work.

One of my earliest recollections of the effort to distribute the insurance on what was then rather a large cotton mill, about 1850, was calling upon the President of one of the most prosperous fire insurance companies of Boston and asking him if he would insure cotton mills. "Oh, yes!" he replied. I began unrolling my plans, when he remarked, "Perhaps you misunderstand me; we will insure them to burn up at a very low rate, but we do not insure them against loss by fire at any rate." That company was wrecked by the Boston fire. During that year the income of the Boston Company from premiums was \$114,536.53, the maximum hazard taken on a single risk \$50,000. There were then seven of the Senior Mutual Companies in existence, in one of which, the Arkwright, the undersigned had aided in the organization and was a Director. At that period a very large proportion of the risks were placed by each treasurer or owner in the hands of the late Edward E. Manton, to be distributed among the several companies; the customary rule being to assign to the Boston Company two parts and to the other senior companies one part each in the same proportions. There were many large establishments which the Mutual Companies could not fully cover, and for that and many subsequent years the excess was distributed among certain Stock Companies with whom

arrangements had been made to carry the excess at the same rate of premium without dividend which was charged by the Mutual Companies subject to dividend.

The undersigned, after twelve years' active service as Director, during which the system had become of great interest to him, became President of this Company, February, 1878. In the interval between 1865 and 1878, three of what are now classed as Senior Companies had been added to the seven previously organized and seven of the so-called Junior Companies had been organized. But the Associated Mutuals were still unable to carry with safety the entire insurance of several of the largest establishments. The total amount at risk in all the Companies at that date was less than two hundred million dollars (\$200,000,000); the total revenue was a fraction over eighteen hundred thousand dollars (\$1,800,000). It was therefore necessary to place considerable amounts on the largest establishments in Stock Insurance Companies, and it was greatly to the convenience of the various Boston treasurers that all this work should be conducted through one channel. For several years this work was done under the supervision of Mr. R. W. Toppan, who is now the President of the Arkwright Mutual and the Paper Mill Mutual Insurance Companies.

In 1878 the revenue of this Company from premiums was \$366,000—the maximum hazard on a single risk, \$80,000. The liability to assessment was still created by the execution of notes promising to pay five times the cash premium in any emergency. The giving of these notes was often objected to, and was in fact superfluous. Measures were presently taken for a change of the law by which the acceptance of the policy created the liability,

but it was evident to the undersigned that the cash receipts ought to be brought to so large a ratio to the maximum hazard taken on a single risk, as to render resort to assessment so remote a contingency as to be substantially disregarded, and to that status the present condition of the Company has been brought.

Before 1878 no customary or regular meetings of the Directors had been held. Inspections had been made in a desultory manner by the presidents or secretaries of the several companies about once a year, usually a few weeks before the expiration of the policy. Modern safeguards had not been thoroughly investigated. Automatic sprinklers were known, but had secured little or no attention. There were no experience tables, no classification of risks, and no real comprehension of the relative hazard on different classes. Everything depended on the personal knowledge and the extraordinary memories of Messrs. Manton and Whiting. Losses had been subject to great variation year by year, as will appear from the diagrams submitted with each Annual Report. It had become manifest to myself and other Directors that a very complete change must be made in the conduct of the whole system, and that new safeguards must be found in order to meet the increasing hazard of larger floor areas, mills of many stories in height, higher speed, new dyestuffs, and to anticipate the new hazard of mineral oil, then gradually being introduced as a lubricant, of electricity, etc., etc.

There also existed a feeling among many members such as governs ordinary business, "not to put too many eggs in one basket." Those who did not investigate the subject were governed in the distribution of their insurance by the amount of the policy and not by the proportion of the policy to the revenue of each company. It did not

occur to them, and it does not now occur to many others, especially to applicants, that if the annual income from premiums is three to four times the maximum hazard taken on any single risk, it is as safe for the member to take, and for the insurance company to grant a policy, say of two hundred thousand dollars on an income of nine hundred thousand dollars, as it would be to grant a policy of twenty thousand dollars on an income of ninety thousand dollars. On the other hand, by such a concentration, the relative expenses of conducting the several companies are greatly diminished.

In 1878 the first duty of the President was to eliminate poor risks; the amount of insurance written was forty-three million dollars. In that year and the next a large amount of insurance was cancelled which could not be brought to a proper standard of safety, but new risks were added, so that in 1879 the amount written was forty-four and one-half million dollars.

Measures were taken to establish a quarterly inspection under the supervision of Mr. William B. Whiting, the Secretary of this Company. A regular system was organized, the accounts being kept on the books of the Boston Company, the charges being shared in proportion to the relative service by all the Senior Companies and a portion of the Junior Companies. At a later date an association was formed to conduct the system of joint inspection at the joint expense of all the Companies, since which date the accounts have been kept upon a separate set of books. The executive officers now meet in monthly conference.

In 1880 what may be called the science of preventing loss by fire was fairly entered upon, and at that date measures were taken, after careful consultation with the very few manufacturers, notably Messrs. Edward Kilburn and

Thomas J. Borden, who had at their own motion put in the automatic sprinklers, for the extension of that service, which has now become practically universal. Without their support and the confidence due to their practical experience, the writer would have had much more difficulty in promoting the adoption of sprinklers, as some of his own Insurance associates were sceptical, and two were positively opposed to them. But the writer had become convinced that, unless the hazard of larger and larger factories, higher speed, etc., could be met, the mutual system would break down; and he then told his associates that automatic sprinklers must be made a condition, cost what it might. In ten years more than half the work was done; in twenty years it has been completed.

In 1879 a careful compilation was also begun, by which the combined experience of all the Mutual Companies could be registered year by year. In this Company risks were divided into ten classes; losses were sorted in proportion to risk taken and premium received from the beginning of the Company to that date. A very wide variation from the average was disclosed. On one class the loss had been over sixty per cent. of the premium received; on another it had been but ten per cent. Measures were taken for the more complete protection of the risks in which the heavy losses had been disclosed and rates were raised. On other risks slight concessions in rate were made; but since the number of hazards in each class, with the exception of three, did not suffice to establish a rule, one loss of considerable amount throwing the average out for a number of years, time was allowed to elapse to justify further changes, if any were required.

Various changes have been made in the adjustment of rates, the inclusion of new risks and the exclusion of

poor risks, so that the average loss of premium received on each class has been brought to as close an approach to uniformity as it is probable can ever be attained. We are occasionally liable to a large loss in a class in which there is a small number of risks, which of necessity throws the average out for a considerable period of time. The compilation of statistics is very necessary as a guide to the judgment of the underwriter, but the President, especially the Mutual underwriter, who should undertake to govern the conduct of the work by giving regard only to the statistics would either fail or would be subject to a very wide variation from any equitable adjustment of the relations of each member to the other.

There have been variations in the judgment of the different boards of directors in the several companies. To some the so-called conflagration hazard has given fear of an assessment; but both the statistics and the observation of others disclose the fact that in the great factory cities, where what are called the single hazards are so near to each other as to suggest the danger of an extension of the fire by conflagration, the additional safeguards in the supply of water and the aid which one mill can render to another have resulted in a considerably less proportion of loss either to risk taken or premium received than is disclosed by the figures of the isolated mills.

No fire in any one of the large factory cities has yet extended in a destructive manner from one risk deemed a separate hazard to another, either in the same yard or in an adjoining mill yard. There have been but five fires which have extended from the building or separate risk in which the fire originated, to another building covered by our insurance to such a degree as to cause a considerable

damage in the second building. These fires have occurred in what are called our isolated risks.

In the first instance, the fire apparatus had not been under a drilled body of men, and in the effort to start it the whole apparatus was disabled. The mill was destroyed, and the fire passing across the pitched and slated roof of a storehouse one hundred and twenty feet distant caused a considerable damage to the stock stored therein. One of the most vital safeguards and one most difficult to secure is a thoroughly trained private or mill fire department drilled in the use of the apparatus belonging to the works. Had such a department been kept in force in the instance above named, the loss might have been very much reduced. Members, especially in the large places, are too apt to rely on town and city departments. In the principal factory cities care is taken to have a very complete understanding between the chief of the mill fire department and the chief of the public fire department, who is by law in authority during a fire. We have on record very many instances of the most judicious co-operation and the careful forbearance of the city departments in not using too much water through hose on a small fire already nearly under the control of sprinklers. Occasionally cases where an over-zealous outside fire department has increased the loss by excess of water. In one instance, after a small fire in a watch-case factory had been put out by sprinklers, a zealous member of a protective department threw a tubful of dirty water out of the window, which was in fact a solution of gold worth about six hundred dollars!

In the second instance of loss on two risks from one fire, two mills sixty feet apart were both destroyed for lack of a sufficient supply of water. They were in a city,

and the city fire department was obliged to draw the water away for the protection of the surrounding property. The means for supplying the city with a more adequate water supply were under contract at the time. In the third instance, two parts of one building, separated by two party walls, with an engine room between, had been insured as separate risks, although under one roof. The whole building was destroyed in about twenty minutes after an explosion, which is attributed to the generation of gas from the previous slow combustion of the stock in the mill, which had not been discovered by the watchman. This explosion threw down the party walls and gave the fire complete control. In the fourth instance, mills were destroyed which had been protected with sprinklers in the rooms where stock was worked in a loose condition, but not in weaving or engine rooms, that being our first standard of adequate sprinkling. The renewal of the policies had been granted by this Company on condition that the sprinkler system should be extended throughout the premises, including the engine room as well as the weaving departments. That contract had been made and also a contract for an additional pump of high power. Six weeks later all this work would have been completed. The fire was caused by the combustion of the wooden lagging from long contact with the cylinder of the engine; and, as it unfortunately happened, the changes in the pump service under way had exposed the steam pump and the pipe connecting therewith, it was disabled. Under these conditions, which could not now recur, the Mutual Companies suffered the largest single loss to which they have ever been subjected. The origin of this fire, from the combustion of the lagging on an engine cylinder, was unprecedented, no similar case being of record. Our own

loss was much less than our customary proportion, the line taken having been very much limited pending the completion of the work agreed upon on the previous renewal of the policies.

There has recently been a fire which passed from one auxiliary building into another in the same yard without substantially doing injury to the main mill, starting in an unsprinkled section (now sprinkled) and extending for want of skill in the use of the fire apparatus; but these two buildings were not considered separate risks according to the construction of that term.

The Mutual contract cannot be safely adopted in the crowded districts of cities for the reason that the owner or occupant of one building may have a very dangerous neighbor in the next, over whom he has no control; he may not therefore expect to reduce the cost of insurance to the lowest standard attained under more favorable conditions.

I once stood by Lord Coleridge at an exhibition of the Boston Fire Department in Boston; and, on his expression of his admiration, I remarked that perhaps he might infer that the skill and capacity of our architects and builders were in inverse proportion to the effectiveness of our fire departments. Since that date there has been much improvement in the methods of instruction in architectural schools and departments, but it is yet impossible for architects to induce many owners to adopt safe methods.

During the fifty years of the existence of this Company there has been no instance of fire intentionally set by the owner or occupant for the purpose of getting money. There has been but one suspicion of such fire, which after some years was disproved by the confession of the incendiary who had no interest in the property. There has been but one resort to litigation. That was in the case

of the Pemberton Mill, which owing to a defect in a cast-iron post fell down, taking fire after the fall. The question was raised by the underwriters whether this was an alteration in the risk not contemplated by the contract, due to the neglect of the owner. So far as I can learn, the case was submitted to arbitration, and was compromised by the payment of a sum of money corresponding to the value of the property after the fall and before the fire. What proportion this came to I am unable to say.

I repeat once more, distrust has sometimes been caused by misapprehension or misrepresentation in regard to the risks taken in the large factory cities, of which there are six in which many mills insured separately are on the same lines of canal and are sometimes held to be subject to a conflagration hazard. The experience of fifty years proves conclusively that the benefit and additional security due to this proximity is much greater than the danger of a fire extending from one mill to another. There has been no such incident. On the other hand, bad fires have occurred in the heart of these cities, with high winds blowing and under conditions which, had they been the ordinary mercantile risks of a city, might have caused an extensive conflagration; but the aid which each mill extends to the other and the enormous flood of water that can be poured upon any single fire from roof hydrants and other vantage points has enabled the well-organized mill fire departments working in co-operation with the city fire departments to put out all such fires without any destructive extension from the building in which they originated. I again call attention to this fact because same precautions and safeguards could be adopted for the protection of city warehouses and blocks, and until they are the appalling danger of great conflagrations will continue.

It has proved to be impossible for the writer to conduct this system of prevention of loss by fire without making some effort to stop destructive fires in cities and in other establishments than those which are insured in the Mutual Companies. To that end I prepared, with the assistance of the late William B. Whiting, a short treatise on "The Protection of our Large Cities from Destructive Conflagrations," which was printed in 1882. A more complete analysis and form of suggestion was printed February 1, 1883. (Copy submitted hereafter.)

The subject of roof hydrants of large capacity, to be supplied by powerful stationary steam pumps, drawing water where possible from a separate source than the city pipes, was held to be of prime importance. Shortly after we were consulted by the owners of one of the largest warehouses in New York. A system of roof hydrants, supplied by a powerful steam pump, was there established under the direction of Mr. Whiting. Within a short time a destructive fire, which caused a loss of about four million dollars (\$4,000,000), threatened this establishment. There was little doubt that the roof hydrants, throwing streams across a narrow, intervening street and over one of the buildings in the block on fire which was but little injured, prevented the advance of a fire under a high wind and probably saved a very extensive conflagration. In the recent very destructive fire in Philadelphia we find another instance, and I may quote from a circular and letter issued by Henry W. Brown & Company, Insurance Agents, under date of January 10th, as follows:—

"It seems a reasonable opinion that this threatening conflagration was limited to the area destroyed, and prevented from becoming a widespread disaster involving many millions of dollars, chiefly through the instrumentality of a 'Roof Fire Service,'

consisting of a powerful fire pump in a safe vault under the sidewalk, supplying a system of six large hydrants located upon the roof of the store of Messrs. Lit Brothers, by whom it was established upon the suggestion and advice of our firm, just in time to render its signal and powerful aid."

In a private note to myself, Mr. Brown says of this report : " I think it will interest you, especially as I owe the idea entirely to you. It is the first time that I have ever seen it applied, and there is no doubt that it saved this city a vast conflagration. The attack upon the heart of the fire from the vantage point was irresistible."

In one other very destructive conflagration, three private pumps working through private standpipes and hydrants from different levels unquestionably stopped the spread of a very threatening conflagration which had already burned over several acres of most valuable property. All these systems had been established mainly at the instance of this Company, although in premises which we could not insure.

If such a system of stand-pipes, roof hydrants, and water supply were extended throughout the great centres of business in our crowded cities, as it might be at a very small expense, the danger of great conflagrations would be almost wholly removed. The time to put out a fire is in the first five minutes, which ought not to be wasted in putting up ladders and carrying up hose.

One or two other incidents may be named. It was formerly the practice to appoint outside adjusters as well as to compromise on an appraisalment; both practices are now ended. Losses are now adjusted by representatives of the owners and of the underwriters as nearly according to the facts as it is possible to appraise them. There has been no difficulty in carrying out this plan to the satisfaction of all parties in interest. Under the former principle

of compromise a very considerable loss had been adjusted and paid, but when the owners, Messrs. Park Brothers, of Pittsburg, cleared up the wreck, much machinery which had been treated as a total loss was found in fair condition. They therefore requested a readjustment and refunded nearly ten thousand dollars to the underwriters. Another pleasant incident occurred in the disposal of nearly two thousand bales of partially burned cotton. It being very desirable to get such cotton out of the mill yard in the shortest possible time, an arrangement was made with a gentleman in New York to work night and day, remove the cotton to New York, pick it and sell it at auction, charging himself with all expenses and accounting to the underwriters for eighty per cent. of the proceeds. The case was managed with great skill; the cotton brought a much larger sum than had been anticipated. The "Jew wrecker," so-called, came on to Boston with a certified check for over ninety thousand dollars. The several receipts were passed, when, to the surprise of the underwriters, this gentleman, Mr. Jacob Cohen, stated that he was not satisfied with the settlement. He had made an error in the computation of the expenses, having obtained much better facilities at very much less cost for handling cotton in New York than he had hoped for. He therefore requested the underwriters to accept an additional check for nearly five thousand dollars. To this the reply was made that he was under no legal obligation, but as the underwriters were agents and trustees of others, they were bound to accept it and a further receipt was given.

It may be added that, in four instances, losses have been settled to the satisfaction of both parties, when subsequent adjustments or events disclosed the fact that very considerable omissions had been made by the owners in

submitting their statement of property damaged, one mistake being discovered many months after the adjustment. In these cases the owners have been requested to submit their additional claims and the amounts have been paid, the intention of the Mutual Companies being to pay, in every instance, the exact measure of indemnity that may be justly due. In another recent instance a loss had been settled by the principal owner, the treasurer being away for his health, on the assumption that the goods stored had been taken in the inventory of a few days before at market values. Two months later, on advices from the treasurer, it appeared that these goods had been valued at twenty per cent. less than market value. The case was re-opened and the difference cheerfully paid.

In only two or three instances that the writer can remember has there appeared to be any effort made on the part of the assured to claim more than a just measure of indemnity under such conditions as to disclose an intent to get more than the true amount. These adjustments have then been made according to the facts; but on the expiration of the policies the representatives have been informed that they could not remain members of the Mutual Companies.

It seldom falls to a business man with no knowledge of science to find his place in an occupation which makes it necessary for him to become somewhat familiar with all the physical sciences and to select experts in every branch. The function of the writer has been to meet all the new hazards of fire as they have come up, to select thoroughly trained men, to study and establish safeguards for each case, and to convert the technical language of the scientist into terms that may be within the easy comprehension of the practical mill managers to the

end that they may be applied, not because insisted upon as conditions of issuing policies of insurance, but through the complete understanding on the part of owner and agent that such safeguards are due to the protection of the property without any regard to any supposed interest of the underwriters therein.

The general conclusions to which the writer has been led are, that it is necessary for the conduct of Mutual Insurance to be as well assured of the quality of the management and the men in charge as of the risk itself. Although this discrimination has formed a constant part of the duties of the executive officers we have reached a general conclusion that there is much less loss from fires intentionally set in order to collect the insurance money or from incendiarism, than is commonly imputed to these causes. I am also well satisfied that when losses that have occurred are taken up by the underwriters with the intention of paying a just measure of indemnity, any effort on the part of the assured to secure a larger payment is uncommon.

I think it never occurred to the founders of the Mutual system and I am sure that it had not occurred to myself, that we were engaged in developing an applied science, not only of the utmost importance to the economy and safety in the Factory system, but which may slowly be of great service in putting a stop to the destructive fire tax of the country. It may therefore be useful to put upon record the gradual growth of our work until its true scope was almost forced upon our minds in the process of working it out.

I have stated that my first effort was to make a statistical account with a complete analysis of the previous causes of loss. No one distrusts statistics more than one

who has compiled as many figures as I have; yet general averages and statistics hold a place in underwriting of greater importance than in almost any other branch of work. In this, as well as in all other branches of industry, true figures compiled by any one who comprehends the subject of which they are the symbols, are as necessary as are the books of account and trial balances of the merchant or manufacturer, the latter being nothing but the statistics of the business. In the course of my business experience of over fifty years, I think I have witnessed more failure or bankruptcy from bad bookkeeping, and from the consequent lack of comprehension on the part of the heads of establishments of their own position, than from any other single cause. In the compilation of statistics, however, the personal equation is as important as it was declared to be by the late Samuel Weller in the composition of a "weal pie."

I have also observed that no persons are more apt to quote statistics which seem to support their pre-conceived theories than those who deride them when they prove the falsity of those theories.

Careful records had been kept by the late William B. Whiting, of the incidents of each fire which had occurred during his official connection with the Company for nearly the whole of the first thirty (30) years, and I was enabled to recover some accounts of the few fires of any importance that had occurred before his time. These fires and their causes were tabulated.

The first fact which was disclosed was the large number of fires and the large amount of losses attributed to broken lanterns. This led to an examination of all the lanterns in mill use, then wholly supplied with animal oils. Not a single safe lantern could be found in use. All were badly

made, liable to melt at the joints and insufficiently guarded. On searching for good lanterns none could be found except expensive brass lanterns made for the railway service. Warnings were given, due precautions taken and, in connection with the firm now called the F. O. Dewey Company, safe lanterns at moderate cost were invented, but it took five years to perfect this apparently simple device. Many improvements have been made and there are now two or three types of safe and suitable lanterns for mill use, burning either animal oil, mixed oils or mineral oils. Since that study of the lantern question there has not been a loss of any considerable amount in any of the works insured by this Company which could be reasonably attributed to fault in the lantern. Careful attention to lanterns would doubtless save many fires and losses in city risks, but what owner or occupant ever gives his personal attention to this insignificant cause of very heavy losses?

The second great cause of fires was found in the various oils in use both for lubrication and for smearing wool. The mineral oils were largely used for lubrication; mixed oils were also used, but in the finest work, especially in weaving, fine sperm oil was still assumed to be the only suitable oil. In smearing wool, olive oil, lard oil and mixtures under fancy names more or less liable to spontaneous combustion, were in use.

The spontaneous combustion of waste had previously been one of the principal causes of loss by fire. This danger has been almost wholly removed from cotton factories by the substitution of the mineral or so-called paraffine (*para affinis*) oils for lubrication, in place of animal oils, the mineral oils having no affinity for oxygen. Our investigation of oil disclosed the fact that thirty-three

per cent. of mineral oil mixed with lard oil would overcome the tendency to spontaneous combustion; twenty-five per cent. mixed with sperm. But these mixtures do not serve in machine tool work. Therefore, there is still a liability to the spontaneous combustion of waste used in wiping tools in the repair shops of the textile factories, where pure lard oil must still be used on the cutting tools, also in all our machine and metal-working risks. The liability to spontaneous combustion in woolen mills has been very much reduced since methods were discovered for scouring wool treated with mixed oils partly consisting of the mineral oils.

Another singular cause of the loss of several pitched roofs of factories, commonly called the barn roof.

When this roof was substituted for the old style factory roof, the practice was common to put vertical sheathing a few feet from the joining of the roof with the floor, making a long hollow space behind the ceiling at the eaves. This was at the time when nothing but animal oils were used for lubrication, when waste was therefore liable to spontaneous combustion. Several roofs were burned. At length one-half of the roof of a mill was burned, the fire being stopped by the tower. It then occurred to some one to investigate the conditions of the unburned part, and behind the sheathing were found large numbers of rats' nests made of oily waste. The cause of the fire then became plain, — the spontaneous combustion of rats' nests. When this fault was discovered all these sheathings were removed, and the space was kept open over the whole area of the attic floor. That barn roof is no longer tolerated.

A little later, during the years of my early practice, a fire occurred in a neighboring city warehouse of excellent construction according to its type, causing a loss, mainly



of goods, of nearly half a million dollars, the building being not very much damaged. The upper stories were used for the manufacture of clothing. I volunteered an inspection, and on one floor found a bench of ovens which were kept in use for heating the smoothing irons. They were admirable and safely placed on a thick non-conducting hearth, which hearth rested upon the floor. Near by was a coal bin. I examined the coal bin, and turning to the principal partner, asked him if he had ever been troubled with rats. "Why, yes," he said, "what do you ask that question for? We paid fifty dollars two or three months ago for the use of ferrets to clear our building of rats, and lately they have been as numerous as ever." Upon that I asked him to send for a man with an axe, telling him that he had established a rats' nursery under the warm floor of the ovens, to which the wharf rats had free way from the sewers, and that he would find the floor under and around the ovens filled with rats' nests of a combustible kind, as at that time only olive oil was used for oiling the sewing machines. Upon cutting away the floor, this theory was verified by the discovery of a great number of rats' nests, which had doubtless caused the fire.

Many destructive fires had originated from hot bearings especially on main shafts. The first fire which called attention to this cause occurred in a basement weaving room two hundred (200) feet long from a hot bearing at one end of the room. The fire jumped from loom to loom, passing many, melting the solder of a gas meter at the further end, without scorching a towel hanging closely underneath. This led to a suspicion of evaporation, it being assumed that the heavy hydro-carbon vapors had been kept in flakes or planes in the atmosphere by the motion of the looms. On examining the oil, it proved to

evaporate twenty-four (24) per cent. in ten hours at a heat of one hundred and forty degrees; that being a heat not infrequently attained on a heavy bearing. Samples were called for from various mills. A tabulation was made of nearly one hundred (100) cotton mills, which proved a very great variation in the cost of oil to a pound of cloth in the quantity of oil used for lubrication and in the prices paid for the oils.

In fifty-five (55) mills on print cloth numbers, among which there was no good reason for any variation in the cost of lubrication, the average price paid for oil varied from twenty-nine cents per gallon to one dollar and five cents. The gallons of oil to a thousand pounds of cloth varied from 1.3 to 2.84. The cost of oil per thousand pounds of cloth varied from sixty-eight cents to two dollars and fifty-eight cents. There was no apparent relation of price, quantity or cost each to the other. This table was printed without giving the names of the mills, and submitted to all the contributors, each with a key to his own number. The conclusion reached by all was that each knew little about the subject, while the rest knew less, and I concluded for myself that I knew nothing and that it was time to bring lubrication to a science if it were possible. This was fairly accomplished. The mineral lubricating oils are now made of various qualities more or less fluid and more or less filtered, but the prices range from a minimum of thirteen cents to a maximum of thirty cents for such oils as are made use of on ordinary cotton machinery. What the relative quantity used in recent years is I have no means of ascertaining.

The investigation was followed up until it proved that there was but one well-distilled and safe mineral oil for lubrication to be found, that being made under a

patent. In all the rest grave faults were discovered, mainly that of rapid evaporation. Notice was immediately given to the makers of these oils that a warning would be published to all our members not to buy them or to use them under any circumstances. This led to a threat of a suit at law for interfering with their business, which I immediately urged them to enter in Court, as I desired to publish the facts; but I advised them to settle the patent rights and to change their methods of distillation, which advice was taken. A year later, wishing to secure some of the volatile oil for experimental purposes none could be found in the market. The price and cost of lubricating oil were very greatly reduced, all oils being brought to a uniform standard; very great benefit in money and increased safety have since ensued. From the conclusion of that investigation to the present time serious losses from hot bearings have been very rare; in fact, there is not one of any moment on our record that I can recall.

Several members reported to me that their saving in the cost of lubricants in the next two years, resulting from this study, had been more than the cost of their insurance in the same period.

A warning was also given on the reckless use of very combustible varnishes on wooden surfaces, over which fire will pass with the speed of a race-horse, and may be ignited by the slightest cause. Care should also be given to the quality of the materials which are used in treating the surfaces of unpainted wood in offices and dwelling-houses, which are apt to be rubbed down with rags impregnated with very dangerous materials of which linseed oil is almost sure to be one of the ingredients. Two instances have occurred in dwellings of my personal friends where these rags, put away in the pantry drawers, have set the house on fire.

Fire-proof paints, so-called, have often been brought to our attention. It would have been better had they been called fire-retardent paints. Several kinds of water paints may be named, which are much to be preferred to oil paints for inside work, because they do not close the pores of unseasoned timber. It is never safe to use oil paints upon timber that has not been seasoned more than three years, as it is certain to generate that kind of decay which is commonly called "dry-rot." Varnishes have already been named as most effective incendiaries, becoming more hazardous from the danger of ignition from electric sparks. Good whitewash, kalsomine or, for more permanent purpose, the water paints, such as Cabot's Anti-Pyre or J. A. & W. Bird & Co.'s Magnite, will retard the ignition of wooden surfaces, especially of rough surfaces, in a very effective manner. Their use is approved, although no great reliance can be placed upon them, except in preventing rapid spread of ignition at the first out-break of the fire. Magnite must not be put on walls when damp.

In the matter of wool oils, many of the fancy mixtures were sold at high prices. We investigated them, proving to the manufacturers that they had better mix their own oils. Suitable instructions were given and precautions were taken against spontaneous combustion. The first researches into the cleansing of wool by the naphtha process, which were made by Mrs. Ellen H. Richards, were published, on which the present practice is based. It now seems probable that this process will displace all others. It has been made safe.

Sawdust is a dangerous incendiary, often used as a dampener on marble floors; in country taverns apt to be used to fill spittoons. The least bit of grease, oily rags and the like will bring on rapid oxidation, commonly called

spontaneous combustion. This is probably the cause of the frequent loss of ice houses, the ice being packed in sawdust in which greasy rags from saw mills have been packed away. A dangerous fire in a hotel was once traced by myself to the dripping of kitchen grease through a crack in a floor upon a barrel of sawdust which was kept in the cellar for sweeping purposes.

I am convinced that in some instances large masses of material, subject to slow combustion, have been ignited in this way, producing large volumes of combustible gas and filling the interspaces of buildings of hollow construction. Presently a spark ignites the gas at a point where it may obtain a free supply of oxygen, then an explosion occurs and a very rapid destruction of the building. I am fully satisfied that this generation of combustible gas from stock in the process of slow combustion has been the cause of at least three of the largest losses to which we have ever been subject. In the investigation, I traced other positive cases of explosion to similar causes. I think these incidents often occur in ordinary fires and are named by the firemen "heat explosions."

I have myself been subject to one alarm from fire in a shed attached to my own house. The watchman on the street five hundred feet away smelled smoke, passed over two or three estates of my neighbors, and finally traced the smoke to a barrel containing rubbish in the shed of my own house. It was but a short distance to the fire alarm, which he sounded, bringing a chemical fire engine. I was awakened by the noise of the firemen putting out the fire, which in the interval had suddenly burst out with considerable virulence in the shed in which my tank of kerosene oil was kept. The origin of the fire was traced to a greasy ham bag in the bottom of a barrel, over which

a lot of excelsior and other rubbish which had been used as a packing in the barrel had been thrown back. Great care had been taken by myself in regard to the ash barrels and the receptacle for rubbish. All in the cellar were of metal, but, in this exceptional case, the barrel from which goods had been unpacked had been temporarily put in the shed, with this greasy ham bag at the bottom. Carrying a policy of insurance on my library in order to make me a member of the Company of which I am President, I was obliged to report this fire in the monthly report, to which I added that "this member had been warned by the President that if he permitted combustible material to be put away in wooden barrels, his policy would be immediately cancelled."

After testing and rejecting every existing kind of apparatus for ascertaining the co-efficient of friction, an instrument was invented by Professor Ordway on which exact results were secured. That was afterward improved in some measure and is now in the laboratory of the Institute of Technology. We may claim that lubrication has become an applied science from this investigation.

Another singular incident occurred during the investigation of lubricants. The undersigned invented a very simple apparatus for measuring the heat on a revolving shaft, which was fully described and published in our first report. Two years later a young engineer came in with a letter from one of the principal machine makers, commending to our attention a very effective invention for measuring the heat on a shaft for which he had secured a patent. I was at the moment reading the proof of the second edition of the publication of my own invention. I asked the young man to read his specifications, which he did. I then read from my own proof-sheet a description

corresponding in almost exact terms to the specifications of his patent, and yet he had honestly re-invented the method which I had published. He had committed no fault or fraud in securing his patent, which was of course without any value.

Methods of lighting were taken up at a very early date. Illuminating gas was mainly in use. There had been very serious fires and heavy losses, coupled with the loss of life, from the breaking of gas pipes during fires, throwing large volumes into burning buildings. Attention was immediately given to outside gates or valves and right methods of cutting off the gas at the outbreak of a fire, which were wholly wanting in many cases.

Having recently volunteered an inspection of a large public building in which there was about a million dollars' worth of uninsured property, three gas meters were found in two boiler rooms (!) in the basement, connecting with a three, four and five inch gas main without gates or shut-offs. Yet only seven gas lights were in use, electric lights having been substituted. This inspection happened to fall on the day after the gas explosion under the Supreme Court in the Capitol in Washington. This inspection led to the removal of the meters and the closing of the gas mains.

At one period there were upon our books one hundred and fifty risks or more lighted by kerosene oil lamps. There had never been any considerable loss from this cause, except from bad lanterns, although many of the lamps were unsuitable. Measures were taken to substitute safe lamps and burners for the poor ones. Attention was given to the quality of the oil in use and the very cheap and dangerous tubular lanterns were thrown out, safe ones being substituted. The number of mills lighted in this

way is now much reduced, electric lighting having been substituted. But from that time to the present there has been no considerable loss of any kind from this cause, and only one loss, slightly exceeding one thousand dollars, which could be attributed to the use of kerosene oil; that was caused by the breaking of a bad lantern brought into the yard from the outside by a workman without the knowledge of the agent.

The next subject investigated was the fire-door. The record showed that iron doors had failed; one of the heaviest losses previously of record having happened from the warping of the iron fire-door which separated the picker department from the main mill, the fire passing and the mill being destroyed. Efforts had been made to introduce the tin-clad wooden door, but it was often badly made for want of proper instructions. The sliding door had been put in position by Mr. Byron Weston. The writer invented an automatic method of closing doors, shutters, and hatches in rather a clumsy way, since very much improved; he fortunately used a lever released by the melting of fusible solder in that undertaking and in the construction of a valve for the conversion of a perforated pipe into an automatic sprinkling system. This invention was published, and the writer received a diploma from the Charitable Mechanic Association for the automatic fire-door. Many years later, after two million or three million automatic sprinklers had been put in position, worked by a lever, a suit at law was brought against the makers of the two best sprinklers of their day by the patentee of a worthless sprinkler who claimed and proved a patent granted on the use of a lever which was not included in the patents under which other sprinkler manufacturers were working. He obtained a

decree in the U. S. District Court in Chicago, came on to the East and entered a suit for royalty on every sprinkler then in use in which the lever formed a part, covering nearly the whole sprinkling system of the country as it then was. The case was brought to the writer's attention, and on examining the patent under which the claim had been made, it proved to be dated one year later than the invention of the writer which he had applied both to fire-doors and to sprinklers, and had published. Of course that ended the suit.

The next subject taken up was fire hose. The practice of the makers of unsafe hose was to recommend to the owners to hang up cheap hose "in order to satisfy the insurance inspectors." Much of it proved worthless. A thorough investigation was made and information was given to all members as to whom they could trust in the purchase of hose. This work has been subsequently extended by the establishment of types of hose designated as the "Underwriter" Hose, which can be readily identified. But incautious persons are still apt to be cheated on low-priced hose offered them at less than any possible cost for hose of a suitable kind. How many owners or occupants of city buildings ever give any attention to their fire hose, except to see that there is enough cheap hose hung up "to satisfy the inspectors of the insurance companies"?

The history of automatic sprinkling need not be repeated. The underwriters moved cautiously, fearing that a fire in a mule room would move more rapidly than the operation of the sprinklers; but presently that fear was disproved by the quick action of the sprinklers in a mill from which a bad roof had been removed only one year. The fire, occurring under a plank roof, was easily held by the sprinklers. A fire which under former conditions

would surely have destroyed the mill was thus stopped with very moderate loss. Gradually both underwriters and owners attained confidence in the action of the sprinklers until the rule set up by the undersigned now forms nearly the universal practice, namely, "To put a sprinkler wherever one can be put, especially in that part of the works where it seems impossible that a fire can originate." Axiom. Beware of the man who says he has the best risk that can't burn — he needs sprinklers everywhere. I have but one instance in my memory of a member claiming to represent the *second* best risk on our books!

One of our members who had fully protected his mill asked me if he should put one over the tail race! To which I had the satisfaction of replying, that in his case it would not be needed, but as we had met one loss from burning kerosene oil flowing on the river and working into the tail race at night, it was one of the places that I watched, and over which I might sometimes call for sprinklers.

One of our largest losses was traced to the misuse of a bucket of water, which I cite as an example of the spread of explosive gases. The watchman had dropped his lantern in the early morning into the slush box of the main gears at the head of the wheel pit, which being filled with lint had taken fire at a level with an unoccupied basement floor. The grease and lint burned with a very small flame and dense smoke. The watchman threw a bucket of water upon the burning mass, which instantly blazed up, carrying the flame up through the belt holes into the room above, leading to the total destruction of the factory. Upon asking an explanation of this incident from President William B. Rogers, he stated that the burning grease and lint yielded hot gases, which not being supplied with

sufficient oxygen at their source these gases spread in the form of black smoke without ignition. The throwing in of the bucket of water upon the smouldering mass produced steam, which has a great conveying quality in regard to other gases. This steam diffused the hot combustible gases, then yielding, gave place for a sufficient supply of oxygen, causing what was virtually an explosion. This was before the introduction of automatic sprinklers, which would have saved the loss.

Another possibly useful but somewhat personal suggestion was made to myself by a member who had become a little irritated through my persistent nagging for sprinkler protection. He remarked that "when I passed on to some other life I had better take a sprinkler with me for my own protection."

The general question of the proper height and the right construction of factory buildings received very early attention. There were then several examples of the eight or nine story factory building surmounted by the early type of the so-called factory roof; the roof itself, in some instances, being two stories in height. One large risk in part under these conditions was dropped as soon as circumstances would permit; the worst building, a large one, having soon after burned. In another instance the owners were induced to remove the two story roof and to put on timber and plank at the level of the sixth story, making place for the machinery previously in the upper stories on the ground. After the work had been done it was justified, not only by increased safety but by the greater economy in the work of the factory.

Many other risks were covered in by the pitched or barn roof, slated, — a very bad type. Later came one of the worst inventions in combustible architecture, the so-

called Mansard or French roof. By persistent action we have secured the removal of many of these roofs, with great benefit to owners in the conduct of manufacturing and very much greater safety.

A bad plan for the construction of paper mills had been long in practice, under the assumed necessity of having a long, hollow roof over the Fourdrinier machines in order to prevent condensation of moisture over the machines, which was one of the worst features of these risks. The losses on paper mills had been far in excess of the average loss on other risks. It therefore became necessary either to induce the owners to remedy the faults of construction or else to drop the risks. The former course was taken, rates being advanced in the interval, and the Paper Mill Mutual Company was organized, so that owners could be trained as Directors in the right construction and protection of their own risks. This action led to a complete revolution in the layout and construction of paper mills, and this change has been justified not only by the greater safety of the works but by very great improvement in the methods of handling the stock. During the last ten years this Company has not met a loss exceeding five thousand dollars on any paper mill.

The subject of heating attracted attention. The common practice between 1880 and 1890 was to heat by steam-pipes which were fastened to the wall at the sides of the rooms, near the floor, where they were apt to be encumbered with combustible materials. In recent years the Sturtevant Blower System has taken the place in almost all new risks of this former method of heating. Several fires had also occurred from the spontaneous combustion, so-called, of wood in contact with steam-heating pipes. The subject was taken up, and after a good deal of dis-

cussion, members were induced to remove the heating pipes from the walls near the floor and to hang them overhead at a short distance from the ceiling; this proved to be the right way of warming the floors, saving fuel and avoiding very many dangers. No improvement which has been presented by the undersigned ever encountered so much distrust, almost ridicule, as this; but by coaxing the incredulous to try it in some small room, the result soon justified the recommendation, and the pipes were moved throughout the works. The most satisfactory case was in a high basement with a stone floor, in which no one could work except in wooden shoes such as are worn in England in stone floored weaving buildings to keep the feet warm. When the pipes were put overhead, the stone floor was soon warmed, and the room was put to use.

In 1880 it may be alleged that there was no true science applied to the covering of steam-pipes to prevent the radiation of heat. In some of the best risks pipes were found wound with straw; hair-felt laid directly upon the pipe was in common use,—both subject to slow oxidation and ultimate ignition. Asbestos was considered a non-heat conductor, even in a compact condition. This subject was taken up, Professor John M. Ordway being charged with the investigation in the first instance. The merits of magnesia as a heat retardent were disclosed by this investigation and very great progress was soon made in the art. At a later date it became expedient to repeat the tests of many new compounds which had been brought into use, and as this matter related especially to economy in the use of steam, the work was done under the direction of the Mutual Boiler Insurance Company, of Boston, of which the writer is President, by Mr. Charles L. Norton, at the Institute of Technology; recent reports giving all

known facts and conditions regarding existing processes or materials for steam-pipe and boiler coverings have been issued. The demerits of compact asbestos have been disclosed, and the merits of air cell asbestos, granulated cork and magnesia covering have been accurately compared.

Grave doubts have been thrown over the possibility of the ignition of wood by contact with steam apparatus, even by steam fitters, against the weight of evidence in our possession. This doubt was finally removed at a very heavy cost by the ignition of the wooden lagging in which a very large cylinder of a compound engine had been encased.

We have a section of the sill of a hotel, which was ignited by a steam-heating pipe under twelve pounds' pressure, when one of our inspectors happened to be in the town, who had the section cut out and secured the pipe.

I once occupied a room in a large southern hotel, where I found the steam pipes in direct contact with the floor-boards, without thimbles. After taking note of the means of escape, I took the risk, and the next morning warned the owner of the risk, to which he at once applied an apparently sufficient remedy. Within a year that wing was destroyed by fire originating in contact overlooked, the guests barely escaping. A good strong, knotted rope is a good thing to have in one's trunk when passing a vacation among the "palatial" hotels at health resorts, many of which are most excellent examples of combustible architecture. We burn about twelve hotels a week in this country. (See Chronicle Fire Report for 1899.)

Fires from the ignition of bituminous coal attracted our attention. It proved that there was but one variety of coal

which had not taken fire, and since a preference or condition for the use of that coal would have given the owners a monopoly, costing consumers much more than any possible loss on the coal itself from spontaneous ignition, it was decided, with the assent of all parties in interest, not to insure bituminous coals against their own inherent hazard, maintaining the insurance of the property endangered by this cause of fire. Actual loss of calorific value by the slow coking of a pile of coal is not very great, although it has sometimes made a great deal of trouble in mill yards. Our present system is fully justified and has worked to the mutual benefit of our members. In this connection it may be related that we shall presently be able to present a report on fire retardent materials for wooden surfaces which can be very cheaply applied to the wooden posts which have not infrequently burned off in the coal piles, and which will entirely obviate that danger, especially the Sackett wall board, which is very cheap and easily fastened to such posts.

Among the earlier lines of investigation was the test of the strength of wooden posts. The common practice had been to turn these posts, tapering them from the base toward the top; this was a waste of material and weakening of strength without any sound reason. Our tests proved the superiority of the square posts chamfered off at the corners, with hole bored through the centre, and a crossway hole near the top and bottom to ventilate and season the timber. This was followed by further tests of the strength of timbers and the layout of plans for the construction of cotton factories consistently with the rather light weights per square foot of floor which are found in this branch of industry. Other general plans for machine shops, paper mills, etc., are also kept in stock.

The basement floor, with air space underneath, had long been a cause of annoyance from decay and occasionally of fire hazard. The hygroscopic qualities of cement floors and the dangers of rot in timbers laid in or upon cement were disclosed. Right methods of laying solid basement floors in and upon asphalt concretes were developed, since justified by the durability of very many floors that have been laid in that way.

Fire escapes were dealt with. The cutting off and separation of belt chambers and stairways, and, finally, general plans suitable for the guidance of architects and engineers, but not as a substitute for their work, have been executed from time to time on all classes of risks that we take. These plans are always held in stock for the use of members, present or prospective.

A method was devised for stiffening high or narrow mills by putting in hackmatack knees, bracing posts to floor timbers, at the several floors, and some mills which had been subjected to very great vibration in the upper stories were put in satisfactory condition. The dangers of unprotected iron and steel have been constantly disclosed.

Our attention was early called to the condition of iron water pipes which had been laid down before the discovery of the means of protecting them from rust by immersion in coal tar. Many pipes that had long been in the ground were found to be corroded or half filled with rust. This led to a complete study of the retarding forces of friction in water pipes and to a complete revision and enlargement of the requisite sizes. Rules were established for the right proportion of pipes to be laid down under the dictum of the late M. M. Tidd, a hydraulic engineer of the highest repute of his day, to the effect that "any one who laid a pipe as small as four inches in any important fire service ought to be hung."

As the subject developed it became evident that an engineer of highest scientific attainments must be brought into the service for the special treatment of the whole apparatus in chief, pumps, pipes and hydrants, and in 1886 the services of Mr. John R. Freeman were secured (now President of the Manufacturers, Rhode Island and Mechanics Companies of Providence). Under his supervision the makers of steam pumps were induced to bring the best pumps to a uniform standard now known as the "Underwriter" pump. The investigation of hose was renewed. Safe types known as "Underwriter" hose were established. But this matter of hose is still one of constant difficulty, owing to the tendency on the part of buyers to try to get hose at a price at which safe hose cannot be made. We give, in our circulars, the names of makers of highest repute in sufficient number to keep up a suitable competition who will supply the safest hose at a fair price. The attempt to buy hose of a safe kind at less than the cost is one of the elements of bad economy which we have often been obliged to overcome.

The rules for sizes of iron pipe, sizes of hose and play pipe, sprinklers and their proportions, are all thoroughly established and have been tabulated; the names of the makers of repute added. These circulars are kept in stock subject to the call of present or prospective members.

The writer happened to witness the first public exhibit of electricity for lighting in the Public Garden in Antwerp in 1877, returning fully prepared for the extension of electric lighting. It was soon introduced under the arc-light system, with naked wires, sometimes one directly over the other. The very frequent fires, fortunately without any very heavy loss in the first year, caused great anxiety. The matter was taken up, however, by our

experts who kept in advance of the inventors, establishing rules for setting up electric lighting plants which have been gradually extended with the progress of the art, but have never been changed in any material point. It is probable that there has been a greater electric hazard insured by this Company than by almost any other Insurance Company in the world and we have yet to meet the first considerable loss that could be attributed to electricity as a cause.

A few years since crude petroleum or fuel oil was brought into notice. It was met by proper regulations for its use in metallurgy, but has not yet displaced coal to any considerable extent in the generation of steam.

The outside covering for flat roofs or roofs of half-inch pitch has been made a subject of investigation down to the present time, each test requiring a long period of exposure, proving that those who have adopted some of the composition roofs, without giving due regard to the integrity of the work or the quality of the materials, often wished that they had put on tin; while those who had adopted tin were sure, in a very few years, to regret that they had not put on the composition roof, in spite of its weight and other objections.

The five-ply gravel roof has been justified when put on by parties that can be trusted to do good work and a good guaranty for ten years. The Sparham Roofing and the Actinolite Cement Roofing, originating in Canada, have been applied by some of our most sagacious members, to their entire satisfaction.

The right covering of light weight for a flat roof, of easy application and sure durability, is one of the inventions which science has not yet placed at our disposal.

A fire retardent covering for wooden surfaces has also

long been sought. Recent very conclusive tests enable us to give directions for plank partitions, faced with heat retardents, which will enable the owners of any works to cut off dangerous processes by wooden partitions rightly protected, with the assurance that the fire retardents will hold the fire on either side as long as any part of the building or floors may stand. These tests have also led to an improvement in fire-doors and shutters, the writer having suggested a composite door of wood, covered on both sides with a heat-retardent material, the whole encased in tin. This subject is fully covered by one of our circulars.

The writer was led by an investigation of English mills, where he found rough-plate glass used for glazing, to take up theoretically the question of the diffusion of light, first experimenting with prismatic forms of glass, and rejecting them for many reasons, finally demonstrating the value of fine-ribbed glass in diffusing light, which has been very widely adopted in modern factory construction.

My reasons for giving a preference to ribbed glass in true curves, twenty-one ribs to the inch, set vertically, were that the main object in glazing a factory is to give a wide diffusion of light and to use suitable glass at the lowest cost. In dealing theoretically with this matter I reasoned that if, by way of the Fresnel lense rays of light could be concentrated into single beams of high power, then by changing the angles of the prisms the rays of light might be deflected on horizontal or other planes. I found, however, that the cost of prismatic glass for glazing would be excessive, and that it would be difficult to keep clean, and by putting various types of glass, including prisms, to the test and photographing the images, it became apparent that for the general purpose of glazing, the

preference would be given on every point to the common ribbed glass then in the market.

Since that date the merits of prismatic glass have been presented in several different ways. It has great merit under certain conditions where it is desirable to deflect light in horizontal planes, as, for instance, from windows opening into basements, where by way of prisms the light can be deflected along the ceiling and then reflected from the white ceiling so as to give the effect of diffusion. There are many places where the special application of prisms may work very useful results.

I submit herewith two photographs; one of a library lighted from a monitor in the roof, which had been very dark when glazed with clear glass, but which has been made very light by the mere substitution of ribbed glass. I also submit evidence of the different effects of light transmitted through clear glass and through ribbed glass upon the vision of children. Photograph No. 1 gives the appearance of a child with its face held toward a window glazed with clear glass, not, however, subject to the direct rays of the sun through the glass. No. 2 gives the aspect of a child's face when the ribbed glass was substituted for the plain.*

This method of glazing ought to be carefully considered by all persons who have the direction of schoolhouses. Cross lights in schoolhouses are condemned, yet the typical Boston school room, twenty-eight feet in width by thirty-two feet in length, is bad in form and bad in construction. If there are windows only on one side, the distance to the inner wall is too great. If there are windows at either end, they give cross lights. The span is too great for true construction. Part of this evil may be remedied by diffusing the light by the use of ribbed glass.

* A fire in the engraving office destroyed these plates while in the process of making, hence it was impossible to reproduce them here.

Later, attention has been given to wired-glass as a fire retardent. We have been enabled to rest content with wired-glass windows at exposed points where we should otherwise have been obliged to suggest bricking up the windows, thus stopping the light.

Under the supervision of the undersigned, the experts of the Mutual Boiler Insurance Company, of which he is President, have also conducted investigations on problems in steam engineering, having reference to explosion, on the calorific value of coals, on steam pipe and boiler coverings and other cognate subjects, which reports have all been placed at the service of the members of the Mutual Fire Insurance Companies and are held in stock for constant use.

Among other incidental benefits to members the writer who had long been vexed, when Treasurer of manufacturing companies, with the difficulties of placing insurance for corporations in the divided form, all policies were then issued in separate amounts on buildings, machinery and stock, and on picker buildings, machinery and stock. An equitable method was devised for issuing blanket policies on single buildings or groups of buildings insured as units.

This renders the adjustment of losses a very simple matter. No reference is needed to minute specifications or to the direct terms of the contract. One of the first losses which fell to the writer to settle on the divided form of policy gave to the assured a partial loss on the buildings, which were over-insured; the face of the policy on the machinery and stock, which were very much under-insured; so that, where the owner had paid premium for full indemnity, yet having neglected a suitable division of the amounts, himself became liable for

a very considerable part of the loss on the machinery and stock.

I once had occasion to appear before the Legislature of Massachusetts with the late William B. Rogers in promoting a grant of land from the State to the Massachusetts Institute of Technology. I then testified to the Committee that I had witnessed a waste, and had shared in part in such waste in the conduct of manufacturing in Massachusetts, due to want of exact knowledge and of applied science in these arts, more than sufficient to have endowed an Institute of Technology in every county in the State. That observation, made during my direct connection with cotton and woolen manufacturing, was what qualified me to become the President of this Company. Having no truly scientific mastery of any of the applied sciences, it has been my function to select the men who might each in his own branch of science work out the problems as they have been presented. To them is due the larger part of the benefits which have ensued. I need not name them. The positions which several of those thus selected by myself now hold as my coadjutors in this work is well known.

It seldom falls to any man in the course of a business life to witness such changes as have occurred in all the arts which have been served by this Company. Many years since Mr. James B. Francis uttered the dictum, that it was useless to plan any building for manufacturing purposes with a view to a duration of more than twenty-five years, except as to the foundation. To-day even that exception has not held. The factory has changed in every part from roof to foundation. The machinery has been changed many times over. It is as impossible to-day to keep one end of a mill up to the first-class or highest standard until the other end is finished, as it was forty

years ago when the principal owner of one of the mills in charge of the writer put that question to him. During this period, what was the waste of the factory and the workshop in the earlier part now constitutes the entire profit of the whole establishment.

This report may fall into the hands of others than the present members of the Factory Mutual System. I will therefore add that reports, plans, instructions, and lists of makers of accepted apparatus are kept up to date on all the subjects which have been named. These constitute what I have sometimes called our missionary documents. They are placed, without charge, at the disposal of any members of any of the Factory Mutual Companies and of all prospective members who desire information, and of mill architects and engineers. (See Appendix.)

It may be stated that no time has been spent in the vain effort to construct or equip fire-proof factories or workshops. There is as yet no fire-proof construction unless an exception may be made in the case of the Boston Public Library, and a few other buildings constructed of cohesive tiles of baked clay, a few iron or steel rods being used, so deeply buried in the clay as to be beyond the reach of heat. We have passed through the age of clay, of adobe or unburned bricks, to the age of untrimmed timber framed with the axe, to the age of framed buildings of wood; then to brick and stone shams or outside veneers, enclosing wooden structures of the most combustible kind; then to unprotected iron framing in brick or stone. We are now passing through the era of steel frames more or less protected from heat, commonly less, from which we shall come around again in the upward spiral of progress to the age of clay free of wood and almost wholly free of metal when the abundant supply of

hydraulic cement of uniform quality and cohesion is attained, which is soon promised from the great works now being constructed in Virginia. (See "Cohesive Tile Construction," R. Guastavino, Ticknor & Co., 1893.)

What the Factory Mutual Companies have attempted is to give a proper direction to the use of timber, plank, brick, and concrete, so disposed that with proper apparatus fires may be reached in the beginning, or may be controlled before they attain destructive headway. Had we not been enabled to compass low cost and economy in construction with adequate security against loss by fire, we should never have been able to accomplish the work which has been done. I have often asked, what has been the cost of fire protection in buildings rightly constructed according to our plans? It is not possible to give a positive answer to that question because the conditions vary with the different arts. In that branch of industry with which the Factory System originated, namely, the manufacture of cotton, the conditions also vary very considerably although not in so great a measure. We are accustomed to make all our computations of the cost of buildings, the appraisements for insurance and fire protection by the unit of the square foot of occupied floor; that is to say, of floor put to use in the manufacturing operations, in hallways, stairways, elevators, and the like, not including unoccupied basements unfit to be used which ought never to be tolerated anywhere. On this basis a tolerable average may be named. The average cost of adequate pumps, pipes, and hydrants within mill yards, not including outside connections or outside reservoirs, will not exceed five cents per square foot of floor, and may often be put in position at less, any excess being due to extraordinary conditions. The cost per square foot of floor of automatic sprinklers

may be put at an average of three cents. The entire cost will range from a minimum of six under favorable conditions to eight cents under conditions which may not infrequently arise. In ratio to values this average expenditure would stand at not exceeding one and a half per cent. for the pump, pipe, and hydrant service, and at an average of one per cent. for the sprinkler service. The cost per spindle will vary with fine or coarse work.

It would interest our members, present or prospective, to inspect the physical laboratory in the basement of the building, 31 Milk Street, where the larger part of the work of investigating and testing apparatus of all kinds is now under the charge of experts who have no outside interests either in pumps, valves, sprinklers, electric apparatus, oils, or any other subjects which are being constantly referred to us for information or test. This laboratory is a department of the Bureau of Inspections conducted for the joint benefit of the Associated Factory Mutual Insurance Companies. A physical test is now in progress, to see if rats and mice will gnaw matches — an alleged cause of many fires. (See Appendix for report.)

One of our most useful functions, still continued in the physical laboratory, is the test and warning against fraudulent and dangerous claims or substances. This work has been especially effective in dealing with fancy oils and mixtures, belt dressings, lamps, heavy gases or mechanical mixtures of naphtha or gasoline with air, claims for improvement in making steam, fire-proof material so-called, and other matters.

In two cases I have had a very amusing experience serving as an amateur detective in exposing the promoters of dangerous frauds, especially in the matter of illumination, mainly with the view of putting stock and bonds upon

the market. A good deal of our useful work has been of this negative kind in exposing either the fraudulent or worthless character of many subjects which have been urged upon our members for purchase and use. There is at the moment a new method of extinguishing fire urgently pressed upon many of our members; the promoters stating in this case, when asked to do so, that they would immediately send examples of their compounds to me to be tested. This has been going on for many weeks, but as yet the promoters have failed to send the apparatus or material to be tested, leaving of course, upon our minds the suspicion of fraud of which we have given warning to the members who have asked us to investigate the subject.

When the Mutual system was first established, the contracts of indemnity were made in the simplest forms, it being held that each member would keep faith with his partners in maintaining all suitable safeguards; one of the inducements in starting the system being to avoid the traps and pit-falls which had become incorporated in almost all contracts of insurance, varying greatly in the different States, to which attention might only be called after a fire. These simple forms continued to be used by this Company until the great Boston fire rendered it necessary for every man who held policies in insurance to read them, in many cases for the first time. The writer was called upon to share in the various efforts which became necessary in the winding up of the Fire Insurance Companies which had failed, and in settling the losses with those which were solvent. He found great difficulty in comprehending the varied and subtle conditions printed in very small type which rendered a very large part of these contracts of doubtful value to those who accepted them; the exceptions in the contracts on buildings, for instance, leaving in many cases only the

skeleton of the building covered by the contract, while in respect to goods or stock the whole question of what constituted indemnity was open. Appeals were made to the Legislature to remedy these evils. It fell to the writer to draft a simple standard form for compulsory adoption on the part of all Massachusetts corporations or of insurance companies licensed by the State. This form, after being put into legal phrase, was substantially adopted. But several limitations were put in which were not consistent with the necessity of the manufacturing work covered by our contracts, provision was therefore made for the remission of these conditions by slips attached and signed on behalf of the underwriters.

There have been many discussions of this matter of forms. Now and then a member reads his policy and its attachments, but not often. Occasionally the matter is referred to his own counsel. Such counsel are accustomed, as a rule, to submit long lists of subjects to be named and covered by specifications in the contract; omitting to note that by making such minute specifications the interests of the assured are very apt to be sacrificed, while under the more general forms established by us as agents of the assured, the interests of the assured have been most carefully protected under the simplest forms that the present acts of legislation will permit.

It may be remarked, that since it is the main or sole purpose of this and other Factory Mutual Companies to find out the exact measure of indemnity due to each member and to pay it, the technical form of the policy or contract is of little moment. In ninety-nine cases out of a hundred each member would be as safe under a record made on his own and on the books of the insurance company without the execution of any policy of insurance as

he is with it. The writer can recall but one instance of a reference to the technical phrases of the contract having been required in making the settlement of a loss. There have been a few instances of reference to the substance of the contract rather than to the form in order to find out under what head the building injured had been listed. Now and then a loss has occurred in an outside building which the owners had assumed to be included in the policy of which the underwriters had no knowledge. In such cases we have been reluctantly obliged to decline paying the loss.

The function of the writer has been mainly office administration coupled with close supervision of the condition of risks from the reports of inspectors. The supervision of the late William B. Whiting, long the chief inspector of this and other Companies, coupled with a most wonderful memory of every detail in every risk, served to establish the relative standard of the different risks in his mind. After many years of supervision by both methods, the writer and Mr. Whiting each went over the whole list of risks insured, marking them on a standard of one to five inclusive, as to their relative merits and safeguards. On comparison of the two lists there was a variation of two points upon only one risk in which Mr. Whiting was informed of causes of hazard which had escaped the notice of the writer. There was a variation of one point on less than ten. On all the rest the marking agreed. This was a very satisfactory test both of the judgment of the two officers and of the quality of the inspections. Since Mr. Whiting's death his place has been filled by Mr. Joseph P. Gray, C. E., who brings to the service high attainments as a civil engineer, with a judgment of risks from investigation and inspection leaving nothing to be desired.

The writer may hope that this record of progress in what may now be justly called the science of preventing loss by fire will have some influence outside the lines of the Factory Mutual Companies. The present condition of the country in respect to loss by fire and contracts of indemnity given by insurance companies is somewhat alarming. All insurance, under whatever name, is a mutual contract to pay indemnity. Under the stock system the capital serves only as a guarantee. It must never be impaired in any great measure for the payment of losses and expenses. The losses and expenses must be covered by the premiums put in by the assured, and it is as impossible for an insurance company to give contracts of indemnity on less than cost for any long period of time as it is impossible for a factory to make and sell goods at less than cost without bankruptcy. The sagacious managers of all insurance companies are now seeking for a remedy for the present dangerous conditions of underwriting. The ash heap due to loss by fire, the excessive cost of fire departments due to bad building and bad occupancy, and the cost of sustaining the insurance system of the country combined, coupled with the excessive demands for additional water supplies for fire purposes only, cannot amount to less than two hundred million dollars (\$200,000,000) a year, and is probably much more.

I can find no trace of any annual profit on the entire business of the nation which would warrant us in estimating the addition to the capital or savings of the people of this country exceeding fifteen hundred million dollars (\$1,500,000,000) even in a prosperous year. It is probably less. It follows that the fire tax is certainly equal to ten per cent. upon any possible profit of the nation,

and is probably fifteen per cent. It is equal to the normal cost of conducting the government of the United States under normal conditions, aside from pensions and interest on the national debt, that normal rate being two dollars and one-half (\$2.50) per head, amounting last year, on a peace basis, to a less sum than this fire tax.

What is to be done to meet this waste? For the last ten years the representatives of the Stock fire insurance companies, especially in Boston, have made consistent, intelligent, and determined efforts to bring about a change, and in some cities great progress has been made in preventing loss, notably in this city of Boston. But in some other cities the danger of a most destructive conflagration still exists, and it is probably only a question of time when such a conflagration will occur, rendering a large part of the stock insurance companies bankrupt which may have large lines in such cities. Without those large lines of insurance their business could not be conducted under existing conditions. This danger of most destructive conflagrations can neither be met by legislation nor by Insurance Companies. The owners and occupants of these dangerous and combustible buildings and districts are responsible for this great danger and must pay the penalty; until they act in combination under intelligent advisers big fires are their own fault.

A few more instructive incidents in connection with fires in premises not insured in Mutual Companies have occurred to me :—

Soon after I became Director of this Company I began to study the causes of fire. At that time I had occasion to make frequent visits to a printing office in the upper story of a very safe building; a building divided into two sections by a brick wall parapeted above the roof and

apparently protected at the doorways with adequate wooden doors encased in tin. The premises becoming too small for the printer, the attic of a neighboring building of a very hazardous character had been leased and a small doorway opened through a brick wall, which was protected only by an iron door. I protested against this, but was informed that the conditions of the lease provided that nothing but iron doors should be placed at that point, and on that condition the doorway had been made. "Very well," I replied, "if there should be a fire in the next building that door will warp, let the fire by, and your premises will be destroyed, possibly the whole building." Within a short time such a fire occurred. The iron door warped and let the fire pass. Some iron fire shutters on a court exposed to the great heat of the next building also warped and let the fire into the stories below. The interior of the building was almost wholly destroyed, the fire passing by the brick wall into the second section, which was very much injured. I was puzzled to know why the fire door had not stopped the fire, but upon investigation I found that it had been fastened to a very heavy wooden door frame which was not protected. The door frame burned away, dropping the fire door into the combustible material which had accumulated in the cellar, from which I recovered it. The wood was charred to the depth of a quarter of an inch.

A previous fire had occurred in the basement of this building, which was of considerable interest. The basement was occupied for the storage of woolen goods in pieces. A fire occurred at the bottom and back part of a considerable stock of heavy woolen goods, which had been piled against the wooden furring to the party wall. In the party wall was a recess, in which the lead water

pipe had been laid, bringing the supply of water. The heat of the fire burned through the woodwork, melted the lead pipe and let on an abundant supply of water, nearly sufficing for its extinction. By not developing the idea of an automatic sprinkler from this fire I lost one of the many fortunes which are frequently missed for lack of suitable comprehension of very plain facts.

Another very bad fire had been called to my attention, being the one which was stopped by the roof hydrants in New York. This fire occurred in a block in which one of my friends was interested. The block occupied a square, each store being separated from the next by a heavy brick wall without openings, parapeted above the roof. It was a mystery to explain how the fire had passed from one store into the next. Upon examination, it proved that the outer walls were of iron, pilastered at each party wall on a long curve wider than the wall itself, the inner face of this iron structure at each pilaster being flush with the end of the party wall, six inches distant on each side, the pilaster being wider than the wall. This space had been finished by the very careful and considerate architect with lath and plaster, so as to provide a free way for the fire around each end of the party wall!

At an early date after my election as President, one of my friends who was on a State commission in charge of the hospitals of the State asked an expert inspection of one of the largest insane hospitals, in which were housed nearly a thousand inmates. It had been constructed by three of the most upright men, one of whom was assumed to be a competent architect, but had cost very much more than the estimates. The roofs were of what I had named the "crazy type," decorated with innumerable dormer windows and with inverted pepper pots and mustard pots

of a decorative order at various points. Very ample preparations had been made for heating and cooking by steam derived from a neighboring building of simple, solid construction, two stories in height. The lower story was occupied by the steam boilers and other apparatus, where a powerful steam fire pump had also been placed. Upon investigating the premises, we found a very dangerous wood-working and paint shop in the second story of this power house, separated only by an ordinary thin floor. A fire in this extra-hazardous room would have disabled the whole heating apparatus and might have unhoused the inmates for several weeks in midwinter, at a loss of a few hundred dollars by fire.

Upon investigating the connections with the steam pump, it appeared that the same pipes were intended to be used for cooking and heating that carried water for the supply of the engine and other parts of the building; and that, in order to work the fire pump at high pressure, it would be necessary to turn a large number of valves off from the heating and cooking apparatus, lest the force of the pump should go in the wrong direction without putting out the fire. A lay-out of automatic sprinklers and a remedy for these defects was made at a somewhat heavy cost. It took two years of assiduous influence on the part of the commissioners to get the requisite appropriation.

The slow-burning principle has been applied in the construction of hospitals in several cases, serving admirably not only in respect to safety, but in keeping the building free from the interspaces in floors and walls, in which vermin and fever germs may lurk. This method meets cases where the very heavy cost of so-called fire-proof or solid construction, in brick, stone or iron, cannot be afforded.



In one case a hospital had been constructed on these lines with little or no regard to outside appearance, and had been condemned in some measure for lack of the ordinary crazy roof and other methods of decoration; but, when a fire occurred by explosion in the pharmacy, where it was extinguished with very slight damage, which in the judgment of the staff would have imperilled the whole hospital had it been of the ordinary construction, the prejudices against this building were removed.

Among other incidents, I once attempted to stop the construction of a building which I thought to be very badly and unsafely planned, one hundred tons of granite resting upon each of several cast-iron girders of twenty-two feet span, the building being otherwise a bad example of combustible architecture; long floor beams resting upon the granite wall, which itself rested on these dangerous cast-iron girders, so that in the event of fire the thrust would be outward across the street, toward a building somewhat taller than the one in process, surmounted by a roof of unprotected iron beams covered with slate. So strong was my fear that I presented the case to the mayor in a letter of several pages, describing the hazard, the probable danger in case of fire; the destruction of the building opposite, even if the fire did not get into it, by the expansion of the iron roof; and the probable spread of the fire over a wide area, if it should once get full headway, with probable loss of life on the fall of the second building. These points were minutely stated in the long memorial to the mayor, who referred it to the proper authorities. But the building was found to be within the terms of the law, and, although the inspector was fully satisfied of the danger, nothing could be done. The construction went on. Shortly after, the architect,

whose name had been unknown to me, threatened me with a suit for damages to his personal reputation, which, on the development of the case to his counsel, was not brought into court. Had it been, the owners of the building would probably have been unable to let it for any purpose. It was let, however, at very high rates of insurance and low rentals. Seven years later the fire known as the "Thanksgiving fire" originated in this building. The building opposite was destroyed by the crushing of the roof before the fire had got into it, some lives were lost, and the course of the fire was such that the Fire Marshal, who called upon me for a statement of the facts, copied my previous letter to the mayor, predicting what would happen, as his report of what had happened.

I once had occasion to go with a friend to examine a new cotton gin in a very large machine shop which might have been of the safest kind. It was not suitable for me to make any remarks upon it, as it was not a risk which I could ever insure, being in the crowded part of a city. On my way out I asked my friend how long he would give that building to stand before it would be destroyed by fire. This excited his surprise. As he had noticed nothing, I said, "In my judgment, I think about two years will serve." Within the year it was subject to a nearly total loss.

These are some of the unpleasant functions of a Mutual underwriter who goes about his daily walk with his fire eye wide open.

One pleasant incident may be named. The assistant engineer of the fire department within the district in which our office is, whom I afterward took from the fire department and made an inspector in our service, was in the

habit of bringing special dangers to my notice in our neighborhood, where he must risk his life if fire occurred, but could make no complaint to any authority so as to secure a remedy. He took me to a brush factory which had been set up in four old dwelling houses in a part of the city then passing from dwelling house to factory use. I found only one or two stairways capable of use, two hundred women and children employed, three or four drying ovens of the most dangerous kind in use, and such conditions of hazard that I was quick to get out of the place. I put this case on trial by newspaper, not giving the name or the exact location, as an instance of great and avoidable danger. The next day a gentleman appeared at my office and put to me the direct question, — "Did you write that article describing a brush factory and its danger?" I said, expecting an immediate threat of a suit, "I did, sir. What have you to say?" His reply surprised me. He said, "I wish you would come down next week and let me show you how I met all the hazards, so far as they can be met, of which I was unaware and am grateful to you for pointing them out; then give me the plans or directions for making plans by which I can build the safest building for a brush factory that can be built." I complied with his request, and a safe factory of mill construction, thoroughly guarded at every point, now stands on the slope of Fort Hill in Boston, known as the Whiting Brush Factory.

Another example of the most ignorant and probably fraudulent undertakings to protect school children against the dangers of fire is to be found in the present conditions of some of the public schoolhouses of Boston. Many years ago what is called the Dunn fire escape was put upon these schoolhouses. It consists of a sort of vertical

iron trough, intended to form one side of a ladder, into which the rungs and the other side are folded, all made of iron, locked with a padlock at the bottom, the intention being in case of fire to unlock the padlock and put the rungs of a very narrow ladder in position for the children to come down from the fourth, third and second stories, from platforms all connected with this one ladder. That has for many years been the sole fire escape on Boston schoolhouses of the ordinary type of combustible architecture, supplied with a single or, at most, two stairways. For many years, after having this fault pointed out to me by the same district fire engineer who called my attention to the danger of the brush factory, I sought a remedy by appealing, year after year, to each new mayor, new school committee or other board which might be assumed to take cognizance of this subject. There were at one time nine public and private boards, committees or authorities taking supervision of this and other subjects connected with the schools. Each rejected all responsibility for existing conditions and put the charge of the remedy upon the other, the mayor turning it over to one body, the school committee to another, the inspector of buildings to another, but all disclaiming any power or responsibility in the matter. These conditions have remained the same for about twenty years. I sent one of my young men an hour ago to some of these schoolhouses, and there he found this so-called fire escape in position, in one the padlock rusted and the janitor condemning it as utterly worthless, himself unable to unlock the ladder. The same worthless contrivance was attached to Faneuil Hall during the period of extreme hazard in that historic building, which, after many years of work on the part of others, with such support as I could give, has at length been

made partially safe. The remedy for the defects in the fire escapes of the schoolhouses waits for the slaughter of a number of children, when possibly some way will be found to make these schoolhouses safe. I have given up making any other effort as a hopeless case.

I could relate many other incidents, some amusing and some quite the reverse. I have been called upon by members of this Company to have inspections made or to make them myself of their own premises in the cities, and there I have sometimes found removable causes of hazard of the grossest kind, which, had I tolerated in their mills, would have led to my being discharged from my office as a wholly incapable person, — another example of the average lack of attention given by most intelligent people to the removable causes of danger by fire.

As I have recounted the incidents in the progress of the Mutual Companies toward greater and greater control of the causes of loss, I am myself surprised to see how quietly and almost unwittingly to ourselves this work has been done. A very large part of work corresponding can be done by combinations of owners or occupants of city property in small or large districts. I have occasionally volunteered to make an inspection of a city block and our inspectors have frequently been called to advise and lay out the protection of hospitals; from this experience I have reached a very profound conviction that by combination of the owners and occupants, even of single squares or blocks, a measure of safety would be assured of which present occupants have little conception. Again, the system of roof hydrants with upright standpipes, to which fire engines can be coupled at the street level, which has been introduced in several cities and may yet be extended

widely, may be carried to such an extent as to make the chance of an extensive conflagration as remote as it is in the six great factory cities, where there are many mills on the same canals, in what might seem to be dangerous proximity to each other, in which cities the aid extended from one mill to another, as has been stated, has rendered loss by fire less than the losses in the isolated mills without such mutual service.

Since the serious conflagration in London, which the writer long since predicted, after a careful survey of the district, with warning to the then Chief of the London Fire Department that his methods would prove very insufficient, a Fire Prevention Association has been formed in London in which are joined engineers, architects, builders and owners of property of highest ability and repute. Under the charge of that Association, which does not issue policies of insurance, researches are being made into the methods of preventing loss by fire corresponding to those which have been in progress under our supervision for many years. But this Committee is dealing with so-called fire-proof method of construction, with city buildings, and with the great conflagration hazards covering a much wider field. It would be well if similar organizations could be made in every one of our great cities, in some of which the gravest dangers are now threatened for lack of adequate water supplies, from bad politics, from corrupt civil service, and from gross neglect of suitable safeguards in very large establishments on the part of the owners. One may ask what right a man has to maintain a great establishment, so dangerous that no Company will insure it, in the heart of a great city, even if he can afford to risk his own share of the loss.

I have dealt with the apparently large figures insured

by the Mutual System. They may give the reader some idea of the true function of the underwriter and of the importance of developing the profession surely and steadily, until the prevention of loss becomes the main purpose of the underwriters, the payment of a loss the obnoxious incident for which the cause must be found and the evil remedied.

The Factory Mutual Companies cover by insurance only about four per cent. of the fire risks on which contracts of partial indemnity are taken in this country. The figures of the last year are not yet available. I think the property at risk in part insured exceeds twenty billion dollars (\$20,000,000,000). The risks correspond to the magnitude of the commerce of this country. In the railway traffic of the last year, twelve tons or twenty-four thousand pounds of food, fuel, ores, metal, timber, fibres and fabrics were moved over some part of the railway system one hundred and twenty-five miles for each man, woman and child of the population, at a charge for the entire service of less than twelve dollars (\$12), or less than one dollar (\$1) per ton carried one hundred and twenty-five miles. This traffic is nearly all covered by contracts of insurance.

The daily transactions, or bargains and sales, of which about ninety per cent. are on a longer or shorter credit, not over ten per cent. for cash, in the materials which serve for food, shelter and clothing, or for their preparation and distribution (omitting transactions in stocks, bonds and real estate), amount to not less than five hundred dollars (\$500) a year for every man, woman and child of our population; that estimate implies less than three bargains and sales between the source of the crude material and the final distribution of the finished product in the retail shop. In many articles, notably in metals,

there may be ten transactions or ten separate fire risks between the ore and the fuel and the consumer. If we rate this commerce at only four hundred and fifty dollars a year, or one dollar and a half per day to each person, that amounts for three hundred business days upon our present population of exceeding seventy-five million in number, to one hundred and twelve million five hundred thousand dollars (\$112,500,000) a day, of which one hundred million dollars (\$100,000,000) is on credit. All this service must be covered in large measure by contracts of insurance, in order that it may possess any element of safety or stability.

Although the method of granting contracts of indemnity by the Factory Mutual Companies must, of necessity, be limited to special establishments, each carefully guarded from the other and fitted with its own apparatus for the extinction of fire, yet there are vast fields not yet covered by this mutual method. The more hazardous the work, the more reason for adopting this system of preventing loss. All the wood-working establishments and many other branches of industry might be combined in the same way; the only thing necessary being to overcome the antagonism with which owners usually regard the underwriters, and to bring them together as copartners, under a sufficient deposit, each sustaining the other in the effort to find out the causes of danger and to remove them.

A mutual insurance company might be organized for the insurance and prevention of fire in church buildings. We burn 11.36 churches per week in the United States. By combination for mutual insurance the church members might be assured against cremation in this world, if not in the next.

It would seem as if there might be sufficient intelligence

among the faculties of universities and colleges, especially those in which there is a department of architecture, to organize a company for the mutual insurance of college buildings and schoolhouses. In 1899, 485 college buildings and schoolhouses were burned, or 10.46 per week, and the rate of destruction is increasing. I have examined several college buildings, memorial halls and the like, and have never found a class in which heavy damage or complete destruction had been more adequately provided for by the masters of combustible architecture.

Again, even in trade and in the commercial hazards of cities there is room for complete organization, inspection and prevention of loss, without undertaking to give mutual contracts of indemnity, but through the personal efforts of owners and occupants securing low rates from existing insurance companies corresponding to the character and judgment developed in the individual protection of the property.

For the information of those into whose hands this report may fall, who are not familiar with legislation affecting the contract of insurance, I would state that "the transaction of business," in a legal sense, is limited to the execution of the contract. Inspections, adjustments and other work of that kind are not comprehended within this legal phrase. The transaction of business of this Company, and of all the Senior Companies, is conducted at their offices only, without agencies and without the employment of any brokers or agents, no risks being solicited and no commissions paid to any one. Under the decision of the Supreme Court of the United States, the citizens of other States have the right to take contracts from us under the laws of Massachusetts or Rhode Island, the business being transacted wholly in the office in Boston

or in Providence. While we therefore take cognizance of the statutes of other States in which our risks may be, our contracts are wholly under the jurisdiction of the States of Massachusetts and Rhode Island. Little regard may, however, be given to this matter, the purpose being the prompt payment of just indemnity without litigation.

One can realize what the condition of the United States was under the confederation before the constitution when each State tried to protect its citizens in the traffic with every other State. Unfortunately, the Supreme Court in *Paul vs. Virginia* hold that the contract of insurance is not in a legal sense "commerce." Under these conditions the Codes of every State are incumbered by a mass of useless or noxious statutes of a most absurd kind. Commissioners are appointed to whom reports must be made, which give no real test of the solvency of the Insurance Companies making them; upon these reports licenses are granted to foreign or corporations of other States to transact business, making a quasi State warranty of Insurance Companies managed in such a reckless way as to be wholly unsafe. This being done every device has been tried to prevent the assured from managing their own affairs and choosing their own underwriters. Fortunately, the laws of Massachusetts and Rhode Island are free from the most obnoxious conditions, and the Insurance Commissioners have, during my time, been men of character and capacity, so that the beneficial work of the Factory Mutual Companies has been but little obstructed.

In conclusion, I may add that, without the cordial and hearty support, often critical and most useful, of the Directors of this Company, this work could not have been done. The writer was the youngest member of the Board in 1865. Every person then Director save one who has

retired, has passed away, while there are but two of the present Directors who were on the Board when the writer became President. Yet, throughout all the changes which have been made, and throughout the difficulties in inducing the expenditure of very large amounts of money for increased safeguards, I have been sustained and aided in the most efficient manner by all who have ever been my Directors and Coadjutors. If, in these reminiscences, I have been obliged to be personal, possibly egotistical, it has not been my intention. Without this hearty support of Directors, associate Executive Officers in other companies, and yet more without the efficient service of all the experts who have from time to time been brought into the conduct of the work, the wonderful results which are set forth in these reports would never have been attained. I wish it might be proper for me to give the names of all who have joined, including the present body of experts in the Bureau of Inspections, and yet more the associate officers who have charge of the accounts and records of this Company.

A very large part of the great shops and department stores are badly planned, little consideration having been given in their construction to danger of fire, except in some cases in choosing the material of which the buildings are constructed. Fires have spread with extreme rapidity over open stocks even in fire-proof buildings so called, in which there have been many openings or stairways passing from one floor to another, to the complete destruction of the contents. The Factory Underwriters regard the vertical hazard much greater than the horizontal hazard. They are obliged to deal with very large floor areas, very often of one acre each, sometimes much larger, covered with combustible material. But since the intro-

duction of automatic sprinklers all fires have been stopped with moderate loss from any great horizontal spread. No fire has passed from one floor to another, in any building insured under the supervision of the undersigned, by burning away the thick plank floor in any working department of any mill. In one instance, a fire originating at the bottom of a pile of jute in a storehouse burned through the floor, making a porthole through which a stream of water was thrown to the heart of the fire. The fires which have passed upward or downward from floor to floor have passed either through belt openings which are now nearly abolished, or, getting by the doorways, have passed through the elevator shafts or stairways.

When the automatic hatch was first invented, which was in universal use in all factories under the supervision of the mutual underwriters when the great Boston conflagration was caused by fire passing from the basement to the roof of one building through an open shaft, it was put on view at the Charitable Mechanics' Association Exhibition, and referred to a jury of experts. Their report was substantially in these terms: "A very ingenious invention of doubtful utility on board ships." It never occurred to these experts that there were hatchways and a place for automatic hatches in business blocks.

The true model of a great department store may at some future date be a building without any windows in the walls except, perhaps, in the upper story if a top or roof light does not suffice to show goods for which daylight is needed, electricity serving to give light, and a forced circulation of air warmed and cleansed giving better ventilation than can be attained by opening or closing windows. Such an establishment might be built with passages from floor to floor in separate towers, or stair chambers at each corner,

each carefully cut off at each floor by automatic fire-doors, and with no other openings from floor to floor. The latest storehouses in cities, where narrow areas make it necessary to construct buildings of many stories in height, have been built substantially on this plan. This may seem a somewhat visionary idea, but what stands in the way? If show windows are needed around the lower story, they can be cut off by fire-proof walls and ceilings from the interior, lighted and protected separately from the main building and entered from the towers.

While the previous text was going through the press our experiment has proved that rats will gnaw matches and set them on fire. For two weeks a rat held for purposes of experiment paid no attention to the matches that were scattered about or mixed with his food. Presently he began to gnaw them and apparently got a taste for phosphorous, igniting them. The next rat began to gnaw them immediately, igniting several cards. Whether mice will set matches on fire is the subject of experiment, — an apparently trivial but very important matter.

Attention may also be called to certain new hazards, to which the Mutual Companies have not yet been subjected, especially in the matter of acetylene. A preliminary report on the use of acetylene gas for lighting has been made, stating the dangers and holding out little encouragement that works in which it is used will be insured under the Mutual System. Fortunately, no inducement in the way of economy as compared to electric lighting has yet been presented to any of our members. We have often been asked by our members for judgment upon it, especially with reference to different types of apparatus, to which we make the general answer, that "the objection to the use of acetylene gas cannot be waived, even if the

apparatus appears to be perfectly safe, the main objection being to the quality of the gas itself."

Evidence is given in a recent work on "The Chemistry of Fire and Fire Prevention," by Herbert Ingle, of the Yorkshire College, Leeds, England; published by Sporn & Chamberlain, 12 Cortlandt Street, New York; a very useful book. In regard to acetylene, the statement is as follows:—

"Acetylene, like other inflammable gases, will explode when mixed with air and fired. The firing of such a mixture requires that a portion of it should be raised to above a certain temperature. The temperature is, in the case of acetylene and air, about 900° F., being much lower than with any other common inflammable gas."

The proportions are as follows:—

The ignition of acetylene is at about 900° F.; of coal gas, 1,198° F.

"A glowing splint of wood or a brightly glowing cigar or pipe would thus be hot enough to ignite a mixture of acetylene, although unable to set fire to coal gas and air."

In another respect acetylene is more dangerous than coal gas in a much greater range of variation in the proportions of gas and air which are capable of exploding. The following statement discloses the limit between which explosions may occur:

3 to 82% of acetylene.

7 to 29% of coal gas.

For these reasons it is not probable that the use of acetylene gas will be insurable under the Mutual System.

A word may be said with regard to the use of gas machines, so-called, in which the heavy hydro-carbon vapors

of naphtha and gasoline are mechanically combined with air, then distributed under pressure through pipes for lighting factories. The danger in this, again, is not in the mechanism, but in the quality of this heavy vapor. At a very moderate temperature it separates from the air with which it has been mechanically mixed; under some conditions reverting to the liquid form, but in the form of vapor settling to the lowest point, and flowing freely toward a draught which may be induced by a gas burner or by a boiler furnace or by any other similar cause.

For these reasons the writer has refused policies of insurance on all risks lighted by the vapors of gasoline or naphtha, although this is not an absolute rule throughout the Mutual System.

The carefully guarded use of naphtha and benzine in metallurgy, scouring wool and woolens, cleaning machinery and the like, is carefully provided for under safe rules, with permission by slips attached to our policies. The use of benzine torches, stoves or other appliances of like kind is not tolerated.

It remains only to repeat the suggestion made many years since for the organization of a protective or preventive fire insurance company on the stock principle, by the adoption of which the dangers of great conflagrations may be in part if not wholly obviated.

THE PROTECTION OF CITY WAREHOUSES
FROM LOSS BY FIRE.

It is impossible for the executive officers of a factory mutual insurance company to conduct its business without giving some attention to the excessive, but in great measure avoidable risks which most of its members incur in the storage of their goods in the principal commercial cities and to the danger to which many of their principal customers are exposed in the same places. They have been frequently asked to issue policies upon goods stored in these cities, which they cannot do, but it will not be deemed officious if they submit plans by which this risk may be lessened, in view of the fact that nearly every member of this Company bears some share in it.

The writer lately had occasion to inspect the works of the New York Steam Company, whose pipes are now laid in some parts of the so-called "Dry Goods District" of New York City, and will be further extended in the spring, and he at once suggested to this Company that it might find a large additional source of profit in making provision for the protection of this district from a destructive conflagration, while also preventing, in considerable measure, the danger of large losses even in single buildings.

Within the limits of less than 120 acres of land, or less than 100 acres of buildings in this district, property in buildings and contents has been concentrated, the value of which is computed at not less than \$350,000,000, and probably over \$500,000,000 in value, — or one and a half to two per cent. of the entire capital of the United States, — upon which property premiums of insurance,

computed at not less than \$1,500,000, probably more, are annually paid to Insurance Companies, which premiums have been subject to a loss of more than an average of \$1,000,000 in each year, for the last ten years, — the loss in 1879 having been nearly \$4,000,000, when a great conflagration was barely averted.

A recent report of the underwriters discloses the fact that during a large part of every day, when a heavy draft is made upon the pipes in the upper parts of the city, there is no pressure upon the hydrants at the street level in this district. How shall it be protected ?

It may be remembered that in a report issued in 1880, the writer submitted a plan for the protection of city blocks by means of five or six inch stand pipes at two corners of a given acre of buildings, more or less, to which might be attached horizontal five-inch pipes upon the roofs, fitted with hydrants on each side of each party wall — such pipes to be carried completely around each square of buildings, so that each building could be flooded from at least two points, and so that many streams could be directed from any one block against a fire on the opposite side of either street surrounding it; while the power might be applied from the stand pipe at the corner most distant from the fire.

Great success has been attained by the use of Abner Greenleaf's "Water Tower," so called, in directing a 2-inch stream of water to any given point of a high building, under the control of a single man, even when forced through the telescopic tube which constitutes the main feature of this apparatus, by the combined power of three steam fire-engines. The head of this pipe rises to a height of 50 feet, and the 2-inch stream may be directed from below to a height of 30 feet further, or 80 feet in all,

under the control of a single man working the mechanism at the street level. It would be practically impossible to control such a stream as this by the use of common, flexible hose, worked from ladders.

If this apparatus has enabled fire departments to flood a large building, in several cases, by means of a single 2-inch stream, in time to check extensive fires, how much more effective might be fixed apparatus upon the roofs of buildings from which *two 2-inch streams* or eight 1-inch streams could be thrown into any single building, within a few moments from the breaking out of a fire, from one pump only! The necessary judgment required would be when *not* to use this apparatus, and it might only be called into action by the order of the City Fire Engineers after ordinary methods and a less quantity of water had failed to meet the need.

A careful computation of the cost of such a roof-hydrant service, when iron pipe was higher in price than it is now, brought the total cost far within \$2,000 per acre.

The suggestion now added for the working of this roof-hydrant service is, that there shall be one large steam pump to each acre, more or less, to be placed under a street, sidewalk, or alleyway, to be operated by the New York Steam Supply Company, or by steam from some of the boilers which are in constant use, — steam supplied by the Company being, however, most desirable, as it is maintained at full pressure both night and day, and, therefore, instantly available, — said pump to be supplied with water not only from the street mains, but from wells, one at least to each acre, it being assumed that a full supply of water can be had at almost any point in this district, by driving wells, at very small cost. A less number of larger pumps drawing water from the docks may prove to be a better

method,—the whole hydrant service being connected. These points are matters of detail only.

Thirty-five hundred dollars would be a large estimate for the average cost of such steam pumps, in place ready for use, and if two thousand dollars more be added for wells and contingencies, we reach \$7,500 per acre, or \$750,000 for the entire area of 100 acres of buildings. These pumps could also be kept in use, the men employed, and a revenue derived by pumping water for operating hydraulic elevators in the blocks subject to them.

This apparatus being once established, a saving of one-tenth in the rate of insurance, at the minimum of \$1,500,000 a year—or \$150,000—would be equal to twenty per cent. upon this computed investment in pumps, pipes, and roof hydrants. Such a sum would be ample to cover the cost of an efficient department to take charge of the appliances, keep them in order, and assist in using them under the direction and control of the city fire engineers,—and would yet leave a large profit on the investment to any company establishing such a system.

The conditions in Boston are somewhat better, but there is still great danger in the high buildings which have been constructed upon the 50 acres burned over in the great fire; by which fire eight per cent. of the capital of the whole State of Massachusetts was destroyed. The pipes in this section are ample, and the supply of water is adequate; but it is all from one source, and the rule of the mutual underwriters is to require *two* sources of water supply, each sufficient by itself.

Steam pumps and boilers could be placed under Post Office Square, Winthrop Square, or Fort Hill, Church Green, or perhaps at the junction of Kingston and Bedford Streets, of large capacity, drawing water either from the

docks or from wells ; with pumps of lesser capacity to be served by some of the boilers now in place along the line of Washington Street. The system would not be quite as simple as that presented in New York, for lack of the service of the Steam Supply Company, but it would not be a difficult problem for a competent engineer to protect the entire area from State Street to Kneeland Street, and from Washington Street to the docks, by the expenditure of capital on which a saving of one-tenth of the annual premiums of insurance now paid in this district would yield an ample revenue.

The undersigned submit these views with the full understanding that the present risk and waste of property by fire will continue until it can be made apparent that it will be *profitable* for some person, firm or corporation, steam-heating company, or fire-prevention company to apply the remedy.

There is, perhaps, one effective method, to wit: the organization of

A PROTECTIVE FIRE INSURANCE COMPANY

with a sufficient capital, in whose method of work may be combined protective apparatus, the supervision of risks, the advice as to the safe construction of buildings, and the economy in expense of the Mutual companies, with the security to the assured of the invested capital of a stock company.

In this way the identity of interests between the stock underwriter working for a profit, and the assured working to save property from loss and to protect it, would be established. Ere long there would be no occasion to solicit risks ; the owners of property would seek the privilege of insuring and enjoying the other services which

would be rendered by such a company. There would be no danger of assessment as in a Mutual Company, but there would be the same necessary supervision of risks, and the same necessary attention on the part of owners and occupants lest they should be deprived of the benefits.

Barring the great conflagration, which it is the purpose of this plan to render almost or quite impossible, the rates now charged in the commercial districts of Boston and New York are adequate, even though depleted more than one-third by the expense of conducting the business.

If a great company could afford to abate 20 per cent. of the present rates, applications for insurance would come to it, and would not need to be sought or competed for; and yet the underwriting of such a company would be profitable if the preventive measures were sufficient to guard against the great conflagration, and at, the same time, to reduce the losses in single buildings.

Let it now be assumed that a *Protective Fire Insurance Company* with a capital of \$1,000,000 should be organized in Boston, and should spend \$300,000 for pumps, pipes, hydrants, etc., in the district previously described, maintaining a full corps of engineers and inspectors to supervise the risks and to work the apparatus under the direction of the City Fire Engineers; its work would be its own constant advertisement, and its expenses could be easily reduced to less than half the present rate in stock companies, even if it did not approach any nearer to the standard of economy in the Mutuals.

It might then safely take large risks at a discount of 20 per cent. on the present rates, and it would thereby establish the rate for all other companies sharing the insurance of the same risks. It would, however, add to the insurance premium a special rate of one-tenth for the

special protective service of its fire apparatus and department, and thus secure a profit on this investment. Owners of property would then save one-fifth of the present cost of their whole insurance, and would pay out a tenth upon the proportion of the risk covered by the Protective Insurance Company, to support the preventive or protective service.

Losses would be reduced one-half at a moderate estimate, and therefore the lower rates would pay a better profit to *all* the underwriters than the present rates now do; thus all parties in interest would share the gain which would accrue from saving property from destruction — the best possible source of gain.

In the city of New York a company with a capital of \$5,000,000 could well spend \$2,000,000 for protective apparatus in the Dry Goods District and elsewhere, and could control the rate or cost of insurance throughout the city. If it is objected that even with the preventive apparatus established there would yet be a limit within which the risk of such a company must be kept, it may be admitted — and yet very large risks could be carried in the same streets and upon the same blocks, the danger of fire passing from one risk to another being almost wholly abated by the precautions which the inspectors and engineers of the company would advise the owners to adopt, and by the instant flood of water which could be poured from above into any single building from the hydrants upon the neighboring roofs, it being remembered that each block may be so connected with others, as to be well guarded from without, as well as from within its own area.

The owners of premises in the upper stories of buildings in which dangerous manufacturing work is now done would also be advised to *insure themselves* by placing

automatic sprinklers in every room thus occupied, which would cost about \$2,000 per acre of floor thus protected.

It will be admitted that this prospective gain is based upon a theory, but that theory is founded on the experience of underwriters who have reduced the cost of insuring cotton, woolen, and paper mills to much less than the average rate of premiums now paid for the insurance of churches, schoolhouses, hospitals, and asylums of the best construction.

It may, perhaps, be considered somewhat presumptuous on the part of the undersigned to attempt to cope with this problem or to present comprehensive plans, calling, perhaps, for investments of many hundred thousand even some millions of dollars; but this is in very truth a burning question, which can only be met by the most comprehensive treatment of the subject, and the time is, perhaps, propitious. It is becoming difficult to obtain adequate insurance, especially in New York City, at advancing premiums, and it may soon become impossible at any rate. A serious conflagration there or elsewhere would compel protective measures to be adopted, and would, perhaps, put an end to the system of betting that bad risks will not burn. The sum of money annually paid to insurance companies by the assured in this country is over \$90,000,000, of which 60 per cent., in round figures, was expended in payment for losses in the year 1882; to that extent distributing the special effect of a portion only of the fires during the year; the expenses of the year 1882 more than absorbing the remainder.

It may not, therefore, be amiss to present the most comprehensive plans, if they are based on the long experience of the factory mutual companies, and if that experience proves that more than one-half of this vast

sum of \$90,000,000, (in 1899, \$132,221,000), annually paid out in largest measure by manufacturers and merchants, is *absolutely wasted* in an abortive attempt to distribute losses caused by fire, under a system which inevitably breaks down in the time of utmost need, and which cannot meet the stress of a great conflagration.

If one-half this sum can be saved by adopting methods of preventing fires, such as we herein suggest, or \$45,000,000, then \$5,000,000 of such salvage might well be set aside as a *profit* to those who establish the system, place the protective apparatus, supervise the risks, and aid in putting out the fires, and also instruct the owners of the buildings how to avoid the dangers of combustible architecture.

If, then, \$5,000,000 out of \$45,000,000 saved may thus be assigned, it would be 20 per cent. annually upon a capital of \$25,000,000.

If one-half of this capital were invested for the protection of the commercial districts of all the great cities, — which would be no more than a fair proportion, — it is not presumptuous for the undersigned to express their opinion that great conflagrations would be fully guarded against and prevented, so far as it is now possible for human foresight to make such provision for safety, without tearing down nearly all the buildings and reconstructing them on some other plan than that which has been rightly named *the art of combustible architecture*; an art under the practice of which the rule of danger, rather than of safety, marks nine out of ten of the works, warehouses, hotels, hospitals, churches, and other principal buildings of this country.

Can there be any more legitimate source of profit than that of gaining a small share of the useless waste which

now afflicts this country, and is one of several kinds of waste which makes this the most productive country of the world, about the dearest one to live in?

This plan is sustained by the judgment of Mr. William B. Whiting, whose long practical experience in establishing means of protection in factories gives weight to his opinion, and in its general features it is declared to be perfectly feasible by several most competent engineers to whom proof-sheets have been submitted.

Respectfully submitted,

EDWARD ATKINSON.

February, 1883.

Many of the safeguards named in the foregoing treatise have been adopted in several cities, but I know of no systematic study and plan for the full protection of any district in which great conflagrations are sure to come at intervals.

Attention may once more be called to classes of buildings which, of all others, ought to be and could be made safe, if the danger of fire were kept in view from the laying of the foundation to the completion of the work.

In the year 1899 fires more or less destructive, in some cases accompanied by loss of life, occurred in the following classes of buildings:—

	Per Week.	Total.
Churches	11.36	591
Schoolhouses and College Buildings	10.46	485
Theatres, Opera Houses and Public Halls	5.36	279
Hospitals and Asylums	2.38	124

It must not be assumed that the large reduction in the ratio of losses which has been brought about under the Factory Mutual System has been attained without cost; although the methods of construction brought into use have been at less cost than is commonly found in buildings of any character or stability outside the mutual lines. But the protection by safeguards against fire with pumps, pipes, hydrants and sprinklers has been a heavy charge; yet one that has long since been more than recovered by lessened loss and larger dividends on each year's policy; yet more, perhaps a greater benefit has ensued in preventing the interruption of a profitable business by fire which often causes a greater injury than the money loss on the property itself.

While it may not be possible to apply all the rules and methods to the miscellaneous hazards of a city, yet a very large part of the safeguards which are required by the Mutual Companies, as a condition of insuring property, have been brought into use for the protection of the commercial hazards of cities and can be extended rapidly when owners and occupants can be aroused to the necessity.

The proposed Protective Fire Insurance Company is but one method by which the interest of the capital invested in a Stock Fire Insurance Company and the interests of the owners and occupants of the property insured may be unified and mutually promoted.

If the facts given in this somewhat desultory treatment of a great subject shall tend to save a part of the enormous fire tax to which the country is now being subjected, the writer will be justified in its publication.

EDWARD ATKINSON.

BOSTON, MASS., U. S. A.,
March, 1900.

APPENDIX.

APPENDIX A.

BOSTON MANUFACTURERS MUTUAL FIRE
INSURANCE COMPANY.

DIRECTORS, 1850-1900.

* James Read 1850	* Charles H. Joy 1876
* William Amory 1850	‡ Frederic Amory 1877
* James S. Amory 1850	‡ George Dexter 1878
* William Dwight 1850	Thomas J. Borden 1878
* Charles H. Mills 1850	Henry F. Coe 1879
* John Aiken 1850	‡ Howard Stockton 1879
Charles S. Storrow 1850	* William B. Whiting 1879
* William Gray 1853	* Charles E. Whiting 1879
* Francis Skinner 1854	‡ Jonathan Chace 1880
* Franklin H. Story 1858	Channing Clapp 1883
* Edward E. Manton 1865	‡ Charles W. Amory 1885
‡ Edward Atkinson 1865	* Henry Saltonstall 1886
* Daniel Park 1866	Augustus Lowell 1886
Edmund Dwight 1867	‡ William H. Bent 1886
* Francis M. Weld 1867	‡ Arthur T. Lyman 1888
* E. R. Mudge 1871	‡ Andrew G. Pierce 1891
* Ebenezer Dale 1871	William F. Draper 1891
* F. L. Richardson 1872	‡ George S. Silsbee 1895
* Ezra Farnsworth 1872	‡ Simeon B. Chase 1895
William Amory, Jr. 1872	‡ Theophilus Parsons 1898
Edward W. Codman 1875	‡ Alfred M. Goodale 1898

* Deceased.

‡ Present Board.

APPENDIX A—Continued.

OFFICERS.

John Aiken	President	1850-1851
William Amory . . .	President	1851-1865
Edward E. Manton .	Treasurer and Secretary .	1857-1865
Edward E. Manton .	President and Treasurer .	1865-1878
* Edward Atkinson .	President and Treasurer .	1878-1900
John L. Hughes . . .	Treasurer and Secretary .	1850-1857
William B. Whiting .	Vice-Pres. and Secretary .	1875-1894
William B. Whiting .	Secretary	1865-1894
Joseph H. Low . . .	Clerk	1850-1881
Joseph H. Low . . .	Assistant Secretary . . .	1870-1881
Roland W. Toppan .	Assistant Secretary . . .	1881-1889
Roland W. Toppan .	Assistant Treasurer . . .	1884-1889
C. J. H. Woodbury .	Second Vice-President . . .	1888-1895
C. J. H. Woodbury .	Vice-President	1894-1895
Joseph P. Gray . . .	Second Vice-President . . .	1894-1895
* Joseph P. Gray . . .	Vice-President	1895-1900
Francis E. Robinson .	Assistant Secretary . . .	1889-1895
* Francis E. Robinson .	Secretary	1895-1900
* John B. Seward . . .	Assistant Treasurer . . .	1889-1900

* Present officers.

APPENDIX A—Continued.

BOSTON MANUFACTURERS MUTUAL FIRE
INSURANCE COMPANY.ANALYSIS OF LOSSES IN FIFTY YEARS
BY NUMBERS AND AMOUNTS.

No. of Fires	Loss	
I	\$ 225,000.00	This was one of the five fires in which two sections of a building which had been insured as separate risks were destroyed by the same fire. An explosion blew down the two parapeted party walls, between which was the engine-room which had been relied upon for the protection of each part from the other.
I	122,913.87	This also was a fire in which two separate risks were either destroyed or damaged, the fire apparatus breaking down for lack of an organized fire department.
I	120,000.00	This also was a fire in which what might have been considered and were deemed by the writer three separate risks were destroyed under conditions which could not now occur in any of the risks insured by this Company.
I	100,011.23	This was considered a single risk in two sections. The two parts were separated by a parapeted party wall, the fire doors were closed, withstanding the heat. A gaseous explosion occurred from gas generated from the stock in the part which was on fire, blowing down the party wall and rendering the destruction complete.
4	\$567,925.10	

In each and all of these four fires automatic sprinklers at the point of origin would, without question, have saved the heavy losses.

APPENDIX A—Continued.

	No. of Fires	Losses
From \$90,000 to \$100,000	1	\$91,742.69
“ 80,000 to 90,000	1	86,671.95
“ 70,000 to 80,000	2	150,337.33
“ 60,000 to 70,000	5	321,572.35
“ 50,000 to 60,000	3	161,952.15
“ 40,000 to 50,000	8	340,592.38
“ 30,000 to 40,000	8	264,954.99
“ 20,000 to 30,000	21	509,248.71
“ 10,000 to 20,000	35	494,029.97
“ 5,000 to 10,000	42	300,486.93
<hr/>		
Total number of fires causing losses of \$5,000 and upward	126	
Average number of fires per year for fifty years causing loss of \$5,000 or more to this Company	2.58	
Total amount of losses of \$5,000 and upward		\$3,289,514.55
Average loss per fire . . . \$25,500.11		
Losses from \$1,000 to \$5,000	174	
Losses less than \$1,000	1623	
<hr/>		
Total number of fires causing losses less than \$5,000	1797	
Total amount of losses less than \$5,000 .		206,974.98
Average loss per fire in this class, \$115.17		
<hr/>		
Total number of all fires causing any loss .	1927	
<hr/>		
Total amount of all losses		\$4,024,749.43
<hr/>		
Average loss per fire, all losses		\$2,088.60

The four losses above designated separately, to which one other instance may be added, in which the loss on the two mills separately insured was less than sixty thousand dollars (\$60,000), constitute over fifteen (15) per cent. of the total loss for fifty (50) years. These are the only cases in which any considerable damage has been done to two risks by the same fire. These were all isolated risks and, therefore, could get no aid from other works near by.

APPENDIX A—*Continued.*

The loss first named, \$225,000, was in a weaving building. The time had not then come when, on the basis of experience, we might rightly have insisted upon sprinklers being put over a building devoted exclusively to weaving, which would probably have saved the loss. Up to that date no fire causing any considerable loss had ever before originated in the weaving department of any mill insured by us.

The second loss designated above, \$122,913.87, occurred before automatic sprinklers were known. Had they been in position, there can be little doubt that the loss would have been saved.

In the third loss named above, \$120,000, the sprinklers were under contract and in a few weeks would have been in position, which would surely have held or stopped the fire in the engine room, where it originated.

In the fourth loss designated above, \$100,011.23, the basement card room, in which the fire originated, was fully protected with pipe sprinklers, but the heat had made the valves stick so that when the firemen promptly reached the premises they could not turn them. Automatic sprinklers had not then displaced pipe sprinklers.

In the fifth case of two mills from which the water was drawn for the protection of the neighborhood; loss, \$59,137.40; the fire would probably have been stopped by automatic sprinklers, but it occurred when this system was still an experiment.

The average loss per \$100 for fifty years has been sixteen and a half cents; the loss in the foregoing five fires comes to a fraction over two and a half cents, leaving fourteen cents per \$100 on all others, — 1922 in number. Dealing with other losses of considerable amount in the last twenty years, which would probably have been held by automatic sprinklers, we find that at the present standard of full protection at least four cents per \$100 would have been saved, justifying the expectation of a future average of ten cents or less, subject to an occasional failure of all safeguards and large single loss.

APPENDIX B.

List of circulars and plans which are kept in stock for the information of present or prospective members of the Factory Mutual Insurance Companies:—

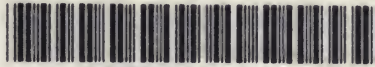
1. General principles of mill or slow-burning construction, with plans suitable for the guidance of engineers or architects.
 - (a) Customary type of textile factory.
 - (b) Mill construction with self-sustaining frame.
 - (c) One-story machine shop building.
 - (d) Two-story machine shop of timber and plank.
 - (e) Plans for weaving building, of one or two stories in height, either with monitor or saw-tooth roof.
 - (f) Brick storehouse of many stories in height; outside entrance to each floor.
 - (g) One-story frame storehouse with plank roof.
2. List of accepted automatic sprinklers, with rules for sizes of pipe, spacing and placing sprinkler heads.
3. Instructions for framing and placing wired-glass windows.
4. Circulars relating to the diffusion of light by the use of ribbed glass for glazing.
5. Fire retardents on wooden surfaces, with instructions for making and placing the safest fire door.
6. Rules for electric plants and fittings, with list of accepted fittings.
7. Specifications for the Underwriter steam pump, with list of accepted makers.
8. Specifications for the Underwriter hose, with list of the accepted makes and makers.
9. Blanks for self-inspection and report.
10. List of makers of repute of all kinds of apparatus used in fire service.

SUPPLIED BY MUTUAL BOILER INSURANCE COMPANY.

11. Steam-pipe and boiler coverings; complete statement of tests, with name of accepted types and makers.
12. Calorific value of the various coals and coke customarily offered.
13. Cost of boiler-room labor, and other documents relating to steam service.



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